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The Roentgen Appearance of Lobar and Segmental Collapse of the Lung: A Preliminary Report[1]

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SOME DEGREE of collapse or atelectasis of the lung, a lobe, or a segment of a lobe, is frequently associated with certain disease processes in the chest, such as foreign body, tumor, bronchiectasis, and tuberculosis. Inasmuch as collapse is often confused with other lesions, in which the treatment differs, as pneumonia and infarct, its recognition is important. In this paper we shall present certain roentgenologic findings in collapse which may be the first to be observed and may be of more importance in diagnosis than the commonly accepted signs—elevation of the diaphragm, shift of the mediastinum, narrowing of the rib spaces, and demonstration of the shadow of the collapsed lobe.

We have restricted the use of the word "collapse" to a decrease in the size of a lobe or a part of a lobe, and of the word "atelectasis" to airlessness.

From a total of 70,000 chest examinations made at the Massachusetts General Hospital during the last six years, we reviewed in detail 1,000 that led to a diagnosis of tumor, bronchiectasis, or foreign body, as well as a number of cases of tuberculosis associated with definite collapse. After discarding the cases for which there were not adequate films in both posteroanterior and lateral projections, there remained approximately 500 cases in which at least one lobe was less than two-thirds of its normal size. The findings presented in this report are based on this series of 500 cases.

TECHNIC

The examination of patients with suspected collapse should begin with fluoroscopy, which will determine the dynamics within the chest and indicate which films will best demonstrate the lesion. In the majority of instances, the routine posteroanterior, the lateral, and the Potter-Bucky or grid projections will give the necessary information. In certain cases, particularly those with bilateral lesions, oblique views will provide additional data. Many cases will require bronchography, and a few will call for laminagraphy for confirmation of a diagnosis.

NORMAL CHESTS

It has been our impression for some time that roentgenologic localization of the fissures of the lung is possible by the demonstration of thin lines of increased density, which we have called septa. The term "septum" rather than fissure has been used because a pulmonary fissure is a potential space, which is not demonstrable

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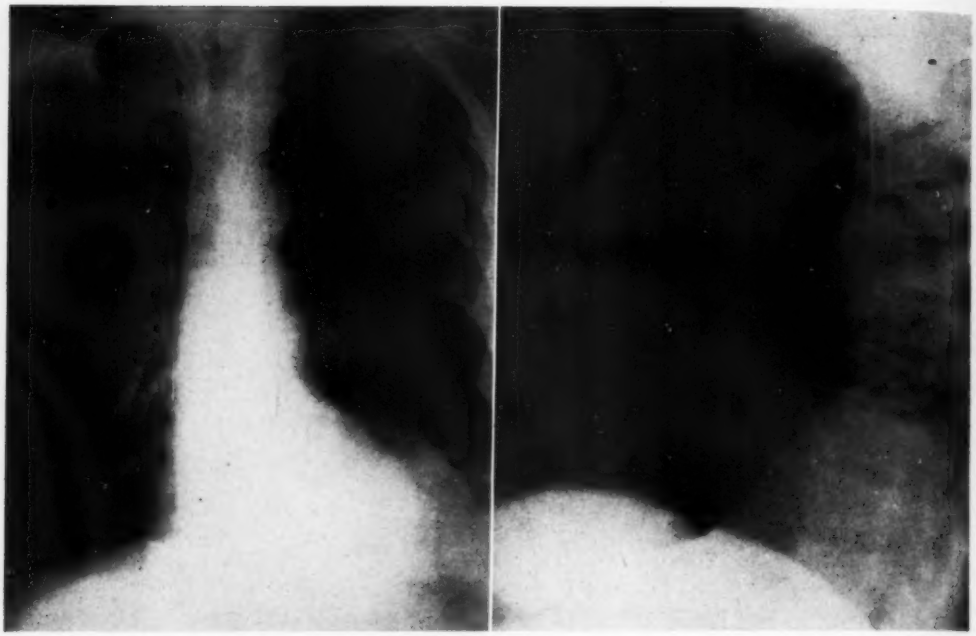

Fig. 1. Case 1 (J. P., U-443473): Collapse of the left lower lobe in a 63-year-old man, complaining of weakness, fatigue, weight loss, dyspnea, night sweats, and cough productive of phlegm with bright red blood, of six months' duration.

Postero-Anterior Roentgenogram: Collapse is not well seen except for the increased density lateral to the apex of the heart. The greater portion of this is due to a tumor. The hilus is not displaced, which is atypical. Emphysema of the left upper lobe, though present, is not striking because of an equal degree of emphysema on the right. The mediastinum is displaced slightly to the left. The left diaphragm is not elevated but is partially obscured.

Lateral Roentgenogram: The shadow of the lower lobe is clearly defined and within it the tumor is well demarcated. The left upper lobe rests on the anterior half of the diaphragm; the posterior half is not seen because of the collapse and tumor. The location of the left fissure is demonstrated by the edge of the collapsed lobe, which lies posterior to the clearly demonstrated septa on the right. In this projection, the tumor is demonstrated as lying posteriorly in the lower lobe; it is of sufficient size to prevent depression of the hilus.

Bronchoscopy: Evidence of chronic bronchiectasis; no tumor seen.

Thoracotomy: Lower lobe hard and non-aerated. Tumor tissue invading pleura. Pneumonectomy impossible.

Histopathology: Epidermoid carcinoma, grade III.

by x-ray, whereas the two pleural surfaces, which are in apposition, cast a well defined shadow. In order to substantiate this impression, and to determine the normal variation and location of the septa, 150 patients who had no pulmonary complaints were examined by means of both postero-anterior and lateral roentgenograms. In the majority of cases, the location of the minor fissure on the right is demonstrable on the postero-anterior projection, while in the lateral view, the major septa, or fissures, are also shown. The major fissures in general run obliquely downward and forward from approximately the fifth dorsal vertebra to the anterior portion of the diaphragm, varying from a point at the anterior chest wall to 6 cm. from it. As a rule, they are straight or gently curved lines as projected on the lateral roentgenogram. The minor fissure on the right, visible in both the postero-anterior and lateral projections, varies in position from the third to the fifth rib anteriorly. Variations from the normal position or curve of the septa may be indicative of collapse.

The study of the normal chest was important also in confirming a second impression, that is, that variation from the normal position of the hilar shadows frequently indicates different degrees of collapse. Anatomically the hili are at about the same levels. On the roentgenogram, however, the left hilus usually appears

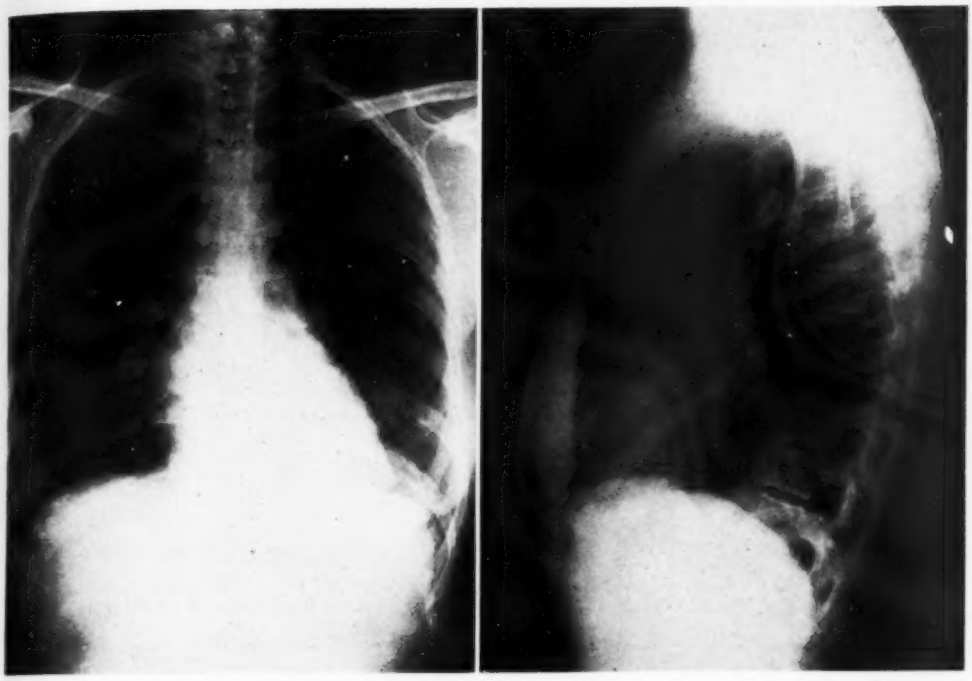

Fig. 2. Case 2 (E. G., U-427028): Partial collapse of the left lower lobe in a 41-year-old woman, with hemoptysis and pain in the left chest, of two months' duration.

Postero-Anterior Roentgenogram: Atelectatic segments of the lower lobe are seen as areas of increased density behind the heart on the left. The hilus is slightly low. Emphysema of the left upper lobe, more marked in the lingula, is due to spatial rearrangement. The mediastinum is in normal position. The left diaphragm is slightly elevated.

Lateral Roentgenogram: The triangular shadow of increased density represents complete collapse of all the segments of the lower lobe except for the dorsal division. The left upper lobe rests on the anterior two-thirds of the left diaphragm. The posterior one-third is obscured by the collapsed segments. The normal septum is not seen. The unimpaired aeration of the dorsal segment probably prevents depression of the left hilus that is usually seen with collapse of this lobe.

Bronchoscopy: Thick, grayish-white mucoid plug obstructs left lower lobe bronchus just distal to orifice of dorsal division. No tumor seen.

slightly higher than the right, since the right main bronchus, which forms the upper margin of the right hilus, is not so clearly visualized as the left pulmonary artery, which forms the upper margin of the left hilar shadow. This study has strengthened our conviction that, although the commonly accepted signs of collapse are of definite value, the position and appearance of the septa and hili are of more importance and may be the first signs suggesting the diagnosis.

ROENTGENOLOGIC SIGNS OF COLLAPSE

Lower Lobes (Figs. 1–3): In general, when a lower lobe collapses, it tends to lie posteriorly and medially against the spine. The hilus is low in position and the adjacent lobe (or lobes) shows compensatory emphysema. In the lateral projection, the anterior edge of the collapsed lobe may be readily visualized, thus indicating that the septum is displaced posteriorly. The shadow of the diaphragm in the area of collapse is lost, and the markings within the collapsed lobe are close together, showing a tendency to curve toward the hilar area with the convexity of the curve anteriorly. It is this collapsed lobe and the increased markings which are often described as the triangular shadow in bronchiectasis.

Fig. 3. Case 3 (K. T., U-242187): Collapse of the right lower lobe in a 44-year-old man, with cough and weight loss for two years.

Postero-Anterior Roentgenogram: The shadow of increased density obscuring the right border of the heart and the medial half of the right diaphragm represents a tumor and the collapsed right lower lobe. The right hilus is moderately low in position.

Lateral Roentgenogram: The tumor and collapsed right lower lobe are shown occupying the postero-inferior portion of the right chest, obscuring the posterior half of the right diaphragm. The right upper and middle lobes show moderate emphysema. The minor septum on the right extends to the posterior chest wall. The major septum on the left is clearly seen and is normal in position.

Right Pneumonectomy: Right lower lobe found quite small, rounded, and very dense and hard.

Surgical Specimen: Lower lobe bronchus obstructed by tumor. Lower lobe very firm, moderately collapsed, and completely consolidated.

Histopathology: Epidermoid carcinoma, grade III.

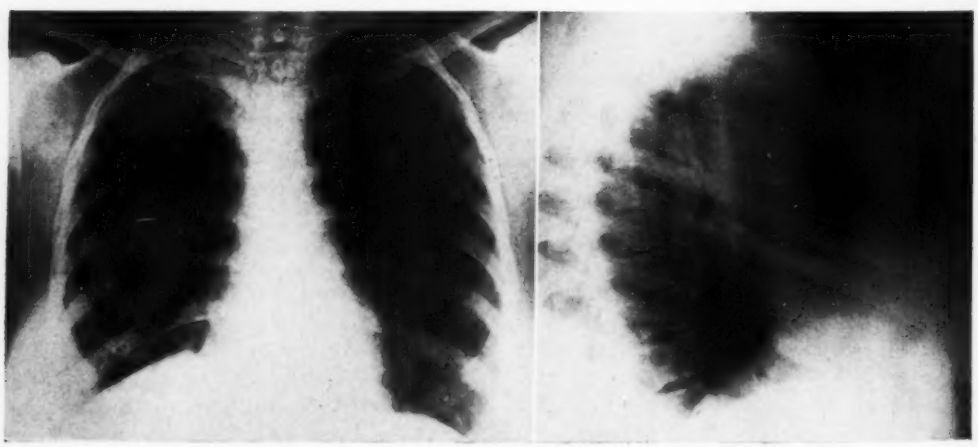

Fig. 4. (M. P., U-455051): Collapse of the right upper lobe in a 26-year-old woman with known pulmonary tuberculosis for three years.

Postero-Anterior Roentgenogram: The shadow of increased density in the right apex represents the collapsed right upper lobe. The right hilus is elevated. The emphysematous right lower and middle lobes occupy the greater portion of the right chest. The trachea is deviated to the right. The right diaphragm is slightly elevated.

Lateral Roentgenogram: The collapsed right upper lobe is seen in the anterior portion of the chest. The right major septum is clearly visualized and is displaced upward and anteriorly.

Right Upper and Middle Lobectomy. Right upper lobe composed about one-third of the specimen, was markedly decreased in size, and contained numerous tubercles.

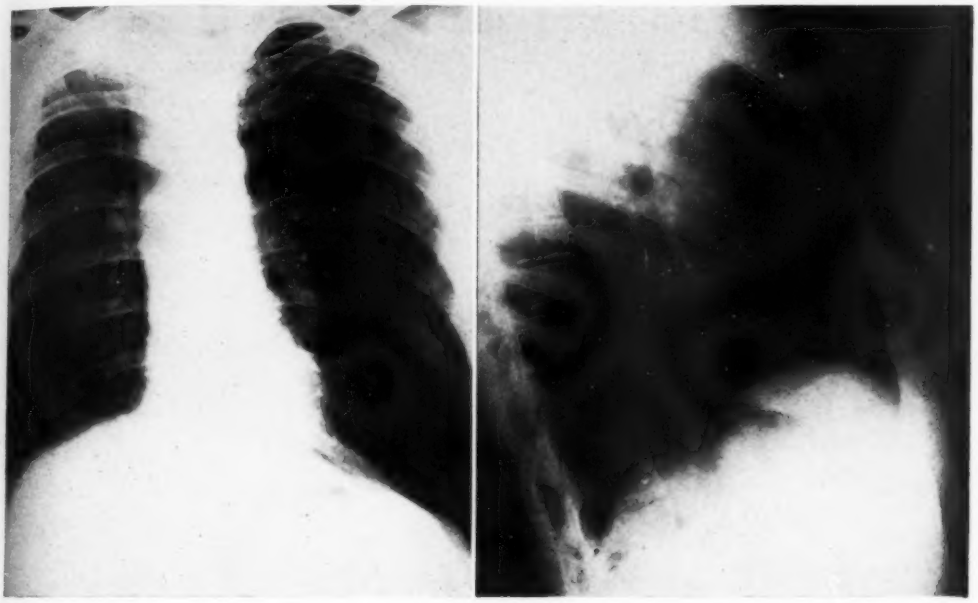

Fig. 5. Case 5 (J. N., U-448275): Collapse of the right upper lobe in a 42-year-old man with chronic cough of four and a half months' duration. Onset followed Type 2 pneumonia. Slight general malaise; no hemoptysis or expectoration.

Postero-Anterior Roentgenogram: There is increased density in the right apical area, with fairly good aeration in the lower portion of the right upper lobe. The right hilus is moderately elevated. The minor septum is slightly higher than usual. The trachea is deviated to the right.

Lateral Roentgenogram: The collapsed area is not well visualized because it is so high in the chest. The major and minor septa are clearly seen and are displaced upward and anteriorly. The posterior portion of the left major septum lies in its normal position.

Right Upper Lobectomy: Atelectatic apical segment of right upper lobe.

Histopathology: Chronic pneumonitis and slight bronchiectasis.

Upper Lobes (*Figs. 4–7*): Collapse of the upper lobes more or less reverses the appearance of collapse of the lower lobes. The upper lobe tends to collapse anteriorly and medially against the anterior chest wall and to obliterate the space that, in the lateral view, is usually seen between the sternum and the ascending aorta. A collapsed upper lobe may become so small that in routine postero-anterior or stereoscopic views it may be overlooked, its appearance being misinterpreted as a slight widening of the superior mediastinum. The hilar shadow moves upward and is indistinct in outline, particularly the upper margin. Adjacent compensatory emphysema is apparent. In certain instances, the entire lung may appear to be aerated, but surgical or autopsy data may reveal that the apparent aeration was due to an emphysematous lower lobe, or lower and middle lobes. In the lateral view, the posterior margin of the collapsed lobe is seen and indicates the position of the septum. It usually forms a smooth curve with the convexity toward the anterior chest wall. The markings are not as well visualized in the upper lobes as in the lower lobes, which is probably due to the fact that bronchiectasis with resulting rigidity of the bronchial walls is less frequent in the upper lobes, and consequently the bronchi also are collapsed rather than air-containing. The mediastinum may be displaced, and more particularly the trachea may be deviated, toward the side of the lesion.

Middle Lobe (*Fig. 8*): The middle lobe frequently shows segmental collapse, and when this occurs the two segments may be

Fig. 6. Case 6 (J. J., U-388860): Collapse of the left upper lobe in a 62-year-old man with dyspnea and hemoptysis of one year's duration. For details of case see opposite page.

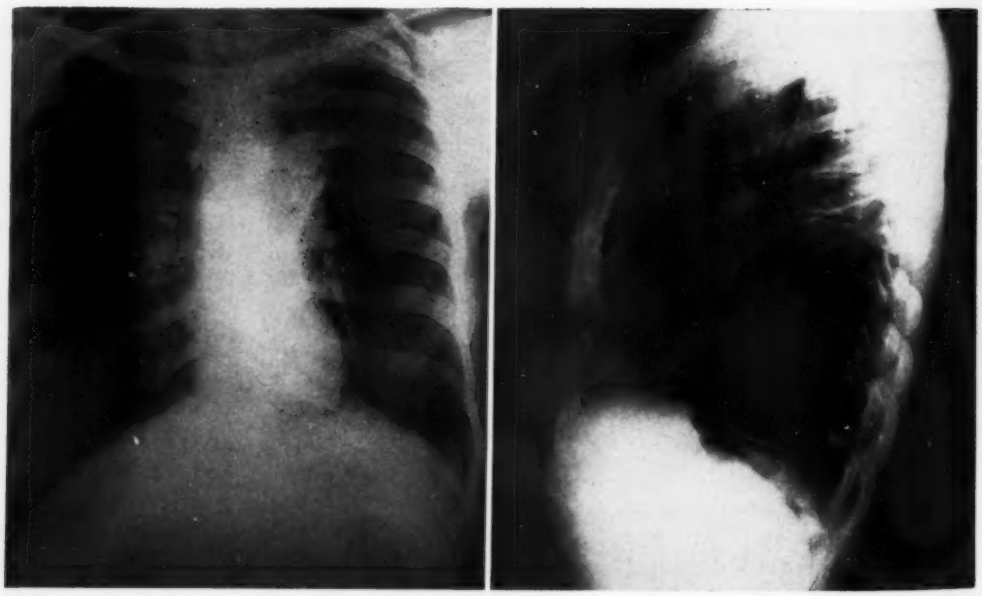

Fig. 7. Case 7 (D. G., U-265728): Collapse of the left upper lobe in a 27-year-old woman with a history of repeated bouts of sinusitis and upper respiratory tract infection since childhood and cough and left chest pain for two weeks. For details of case see opposite page.

Case 6: Collapse of left upper lobe, shown in Figure 6 on opposite page.
Postero-Anterior Roentgenogram: The increased density in the left hilar region and the obscuring of the left mediastinal shadow are due to a tumor and the collapsed upper lobe. The air in the left chest is within the left lower lobe. The hilus is not well visualized. There is an increase in the linear markings of the right upper lobe, with some decrease in its size. The left diaphragm is slightly elevated.
Lateral Roentgenogram: The collapsed left upper lobe and the tumor within it are clearly seen lying against the anterior chest wall. The left lower lobe is emphysematous, extending to the top of the left chest and anteriorly to outline the posterior border of the collapsed left upper lobe. There are a few dilated bronchi in the left lower lobe as evidenced by some bronchiectasis in this lobe.
Bronchoscopy: The orifice of the left upper lobe bronchus was not seen because of a round, nodular, slightly irregular mass almost completely obstructing the left main bronchus.
Thoracotomy: Inoperable, due to enlarged mediastinal nodes.
Histopathology: Epidermoid carcinoma, grade III.

Case 7: Collapse of left upper lobe, shown in Figure 7 on opposite page.
Postero-Anterior Roentgenogram: The area of density in the medial portion of the left upper lung field represents the collapsed left upper lobe. A few dilated bronchi are seen within the shadow. All of the air seen in the left lung field is in the lower lobe. The hilus is displaced upward; the trachea is deviated to the left. The left diaphragm is slightly elevated.
Lateral Roentgenogram: This is the typical appearance of collapse of the left upper lobe. The posterior edge of the left upper lobe is clearly defined, and it is seen that the lobe is collapsed anteriorly against the chest wall. The emphysematous lower lobe occupies the greater portion of the left side of the chest. The septa of the right lung are well visualized.
Left Upper Lobectomy: The upper lobe was completely collapsed.
Histopathology: Bronchiectasis.

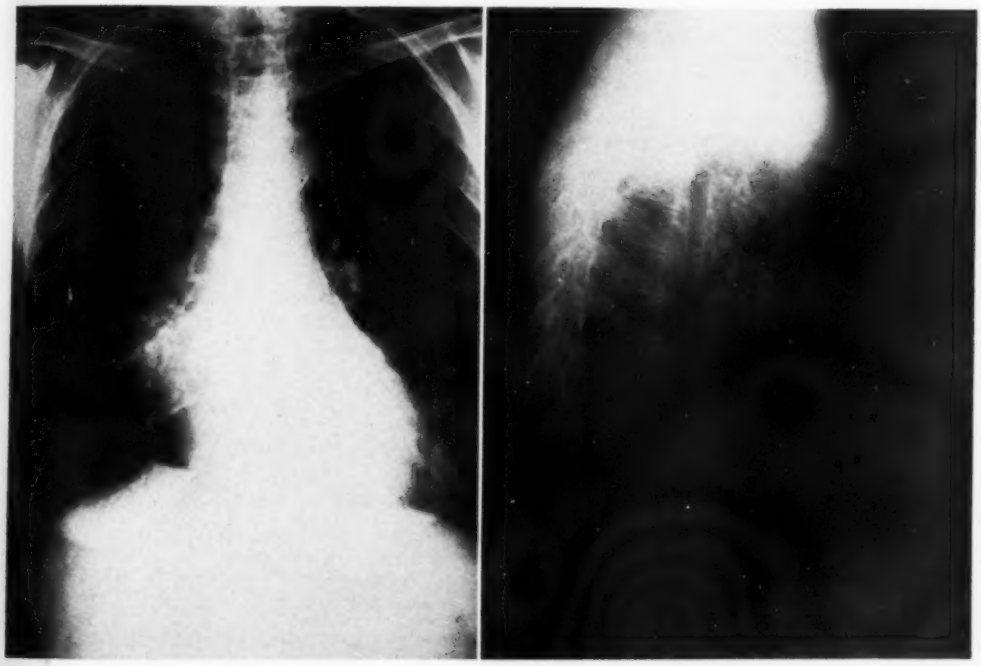

Fig. 8. Case 8 (E. P., U-405062): Collapse of the right middle lobe in a 53-year-old woman with a productive cough for seven months and a history of hemoptysis two and a half months and four years prior to admission.
Postero-Anterior Roentgenogram: The right border of the heart is obscured by the atelectatic right middle lobe. The right hilus is only slightly low. The normal minor septum is never seen in complete collapse.
Lateral Roentgenogram: A triangular shadow of increased density is seen in a much smaller area than is usually occupied by the middle lobe. Slight compensatory emphysema of the upper and lower lobes accommodates for the collapsed middle lobe. Incidentally an area of bronchiectasis is seen in the postero-medial segment of the left lower lobe.
Bronchoscopy: Middle lobe orifice narrowed and completely plugged by thick white-gray secretion which cannot be expectorated by coughing.

demonstrated. In complete collapse, the middle lobe tends to flatten and lies against the right border of the heart, thus obscuring its shadow. In certain cases, collapse of the anteromedial segment of the right lower lobe may obscure the right heart border. The lateral view, however, will enable one to differentiate between the two, since it will show a collapsed anteromedial segment to lie posteriorly, while a collapsed middle lobe will lie anteriorly in the usual location of the right middle lobe. Occasionally an emphysematous anteromedial segment of a right lower lobe will permit visualization of the right border of the heart even when the right middle lobe is collapsed. This is made possible by the emphysematous segment extending far enough anteriorly to outline the posterior portion of the right heart, which normally lies next to the right middle lobe. In many cases the only sign in the posteroanterior projection of the collapsed middle lobe is loss of definition of the right border of the heart, and it is imperative to use a lateral projection to demonstrate clearly the shape as well as the degree of collapse. A lordotic view will confirm the size and shape of the collapsed right middle lobe. When a segment only is involved, the septum between the normal segment and the adjacent lobe may be seen readily. When the entire lobe is collapsed, normal septa are not demonstrable. As a rule, collapse of the middle lobe produces very little change in the position of the hilus, mediastinum, or diaphragm.

CONCLUSIONS

1. This is a preliminary report of a study of the roentgenologic appearance of collapse of the lung and its subdivisions.

2. A technic has been described briefly by which collapse may be best demonstrated, requiring in the majority of cases but three roentgenograms following an initial fluoroscopy.

3. The appearance of the septa and the hilar shadows is of more importance than the usual diagnostic criteria of collapse, although the latter will also be of use.

4. The appearance of collapse of the various lobes has been described briefly.

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DISCUSSION

C. C. Birkelo (Detroit, Mich.): I want to compliment Drs. Robbins and Hale on the splendid paper they have presented, showing a way of definitely identifying the various lobes of each lung. Because of recent developments in thoracic surgery, lobectomies and pneumonectomies for the amputation of tuberculous lesions and carcinoma of the lung are becoming quite common. It is therefore important to show location of interlobar septa and to localize the disease.

Roentgenographic Changes in Bone Infections Treated with Penicillin[1]

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THE RECENT generalized use of penicillin has stimulated interest in the treatment of infections of all types with this biological agent. We have had the opportunity of using penicillin in approximately 25 cases of bone infection, both acute and chronic, with varying results. In general, the period of active infection has been shortened and the clinical results have been gratifying. The following case summaries and illustrations demonstrate what we believe to be the typical changes occurring in bone infections susceptible to treatment with penicillin. Certain of these cases represent old chronic infections, and in these the response was by no means dramatic, although in the majority there was a decrease in drainage, with improvement in the general physical condition of the patient. In some of the cases it was possible to do elective surgery concurrent with the administration of penicillin, with no extension of the infection. In the acute cases which proved susceptible to penicillin, clinical improvement preceded the roentgenographic signs of healing, and the patient became clinically well. We do not

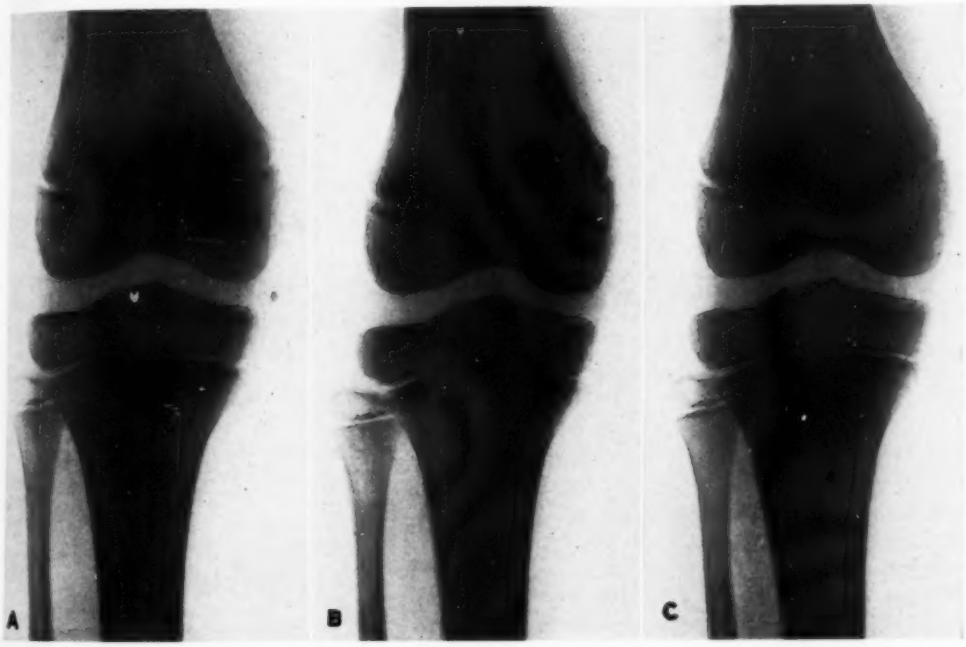

Fig. 1. Case I. A. Roentgenogram taken March 14, 1944, showing no definite evidence of any change in the tibia. B. Roentgenogram taken March 24. An area of rarefaction has appeared in the upper portion of the metaphysis adjacent to the epiphyseal line, accompanied by a very faint elevation of the periosteum. C. Roentgenogram taken April 27. The area of osteomyelitic involvement in the upper portion of the metaphysis shows recalcification, the involved area appearing slightly denser than the surrounding bone. There has been no evidence of sequestration, extension of the process, or involucrum.

[1] Accepted for publication in May 1944.

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Fig. 2. Case II. A. Roentgenograms taken Oct. 20, 1943. Chronic osteomyelitis of the lower end of the right radius. This area and those in the upper metaphysis of the left tibia and the lower metaphysis of the right femur (see Fig. 3) represent osteomyelitis of approximately the same age. There is a moderate amount of sclerosis with no evidence of large sequestra and with only a moderate involucrum. B. Roentgenograms taken April 26, 1944. Corresponding views of the area reproduced in A show no evidence of further extension of the osteomyelitic process, no further sequestration, no further involucrum, and there is recalcification of the previously involved areas, the recalcified bone approaching the normal in texture and appearing only slightly more dense.

feel that it is by any means established that in bone infections treatment with penicillin is a substitute for adequate drainage, when necessary, or for other surgical procedures which have proved of benefit in the past. In a few of these cases the clinical response was so rapid that surgical drainage was not instituted. Not all of the patients showed a prompt response to the penicillin, but in those which did, certain bone changes occurred.

CASE REPORTS

CASE I: E. M. B., an 11-year-old boy, was admitted to the clinic March 14, 1944, with pain in the right knee of three days' duration. Examination showed tenderness over the upper fourth of the right tibia with a slight soft-tissue swelling below the medial condyle anteriorly. There was a slight increase in joint fluid, and motion in the knee was guarded and painful. The temperature on admission was 101°, the white blood count 14,000; urinalysis showed ketone bodies. The roentgenograms were negative (Fig. 1, A).

The administration of penicillin was instituted on admission: 1,000,000 units were given intramuscularly, 10,000 units every three hours. The patient's temperature rose to 103° on the first day, and until the fourteenth day it continued to show an afternoon elevation to as high as 102°. It then returned to 98.6° and remained normal thereafter.

Roentgenograms made March 24, after 800,000 units of penicillin had been given, showed a localized area of rarefaction in the tibial shaft adjacent to the epiphyseal line (Fig. 1, B). The patient was discharged from the hospital on the fifteenth day, with a normal temperature and a leukocytosis of 12,800. The upper end of the tibia was painless.

The patient returned to the clinic for examination on April 27, a month after the penicillin had been given, and roentgenograms (Fig. 1, C) of that date showed recalcification of the area of destruction seen in the earlier films. The area in which bone repair had taken place was slightly denser than the surrounding bone, and there was a slight periosteal reaction around the upper portion of the shaft of the tibia. There was no evidence of sequestration, spread of infection, or involucrum.

CASE II: P. G., a 15-year-old boy, was first seen at the clinic July 30, 1943. His entering com-

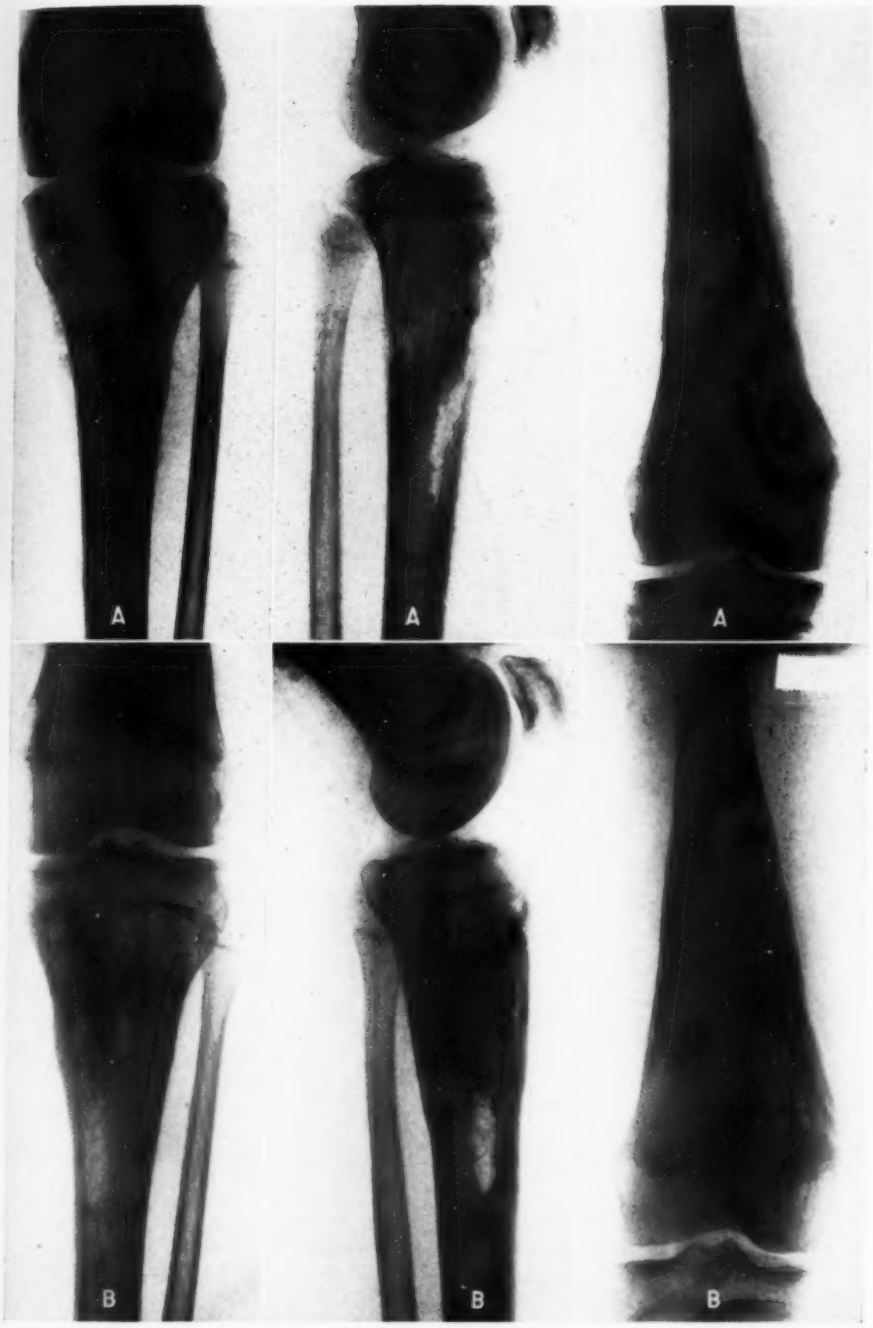

Fig. 3. Case II. A. Roentgenograms taken Oct. 20, 1943, showing osteomyelitis of the upper metaphysis of the left tibia and the lower metaphysis of the right femur. B. Roentgenograms of the corresponding areas taken April 26, 1944, after treatment. See Figure 2.

Fig. 4A. Case III. Roentgenograms taken March 6, 1944. Two views of the right femur show osteomyelitis involving the upper portion of the shaft and apparently invading the trochanteric area. There are bone destruction, early involucrum, and no definite sequestration.

plaint was multiple osteomyelitis of four weeks' duration. The first focus of infection was on the medial aspect of the right foot, followed within a week by foci in the left lower femoral metaphysis, right lower femoral metaphysis, and the right lower radial metaphysis. A soft-tissue abscess of the forearm had been aspirated, a sequestrectomy had been done on the upper portion of the left tibia, and a soft-tissue abscess over the right radius had been incised before the patient was seen here. On examination he appeared seriously ill, with draining sinuses from the right radius and left lower femur, generalized swelling and tenderness of the lower ends of both femora and of the right radius. His temperature on admission was 100°, rising the following day to 104°. His white blood count on admission was 12,800 (polymorphonuclear neutrophils 72 per cent), red blood count 2,850,000. The blood culture was negative.

The patient was admitted to the hospital, and six days later, Aug. 5, incision and drainage of the right lower femur were done. Culture on this date showed *Staphylococcus aureus hemolyticus*. The patient was given numerous blood transfusions. Prior to admission he had received a large amount of sulfathiazole, and this was continued during his stay in the hospital. Roentgenograms taken on July 30 showed multiple foci of osteomyelitis involving the lower metaphysis of the right femur, the lower metaphysis of the left femur, the upper metaphysis of

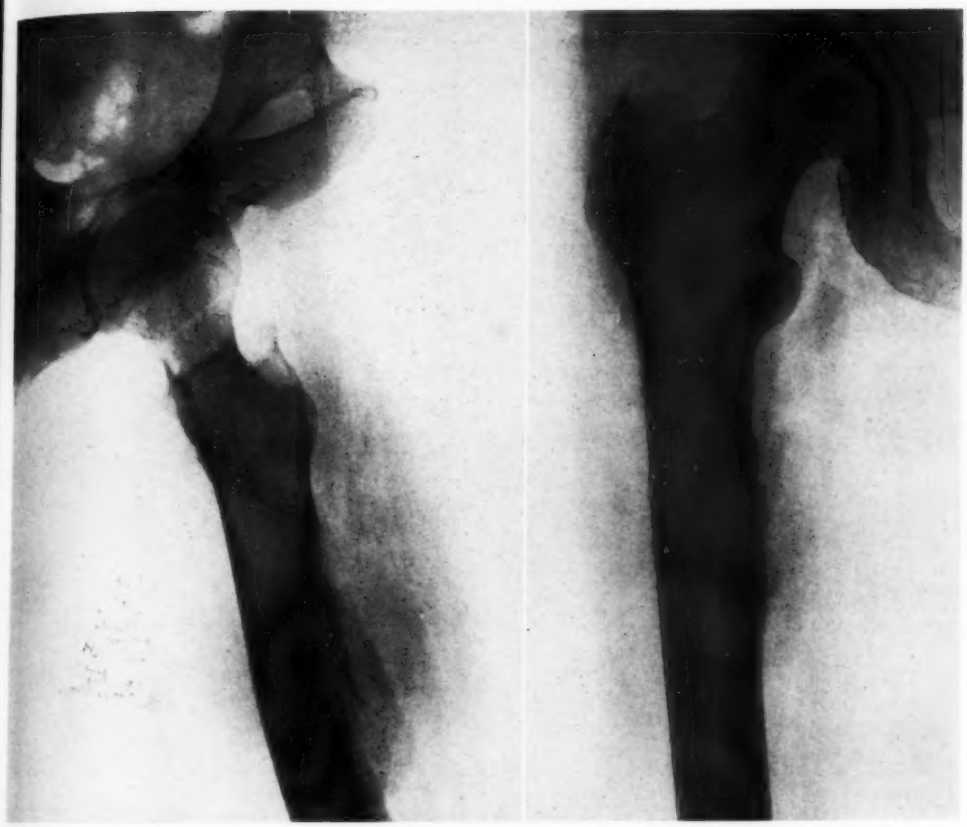

Fig. 4B. Case III. Roentgenograms taken April 10, 1944. There is no evidence of a destructive process, no sequestration, no further involucrum formation. Early recalcification of the involved areas has occurred, the recalcification appearing slightly more dense than normal bone.

the left tibia, the lower metaphysis of the right radius, and the proximal phalanx of the third toe on the left. Under conservative treatment there was a gradual improvement, and drainage decreased, but continued. Improvement was slow, and the roentgenograms showed only the changes commonly seen in osteomyelitis which has been adequately drained, namely, little evidence of sequestration, some periosteal new bone formation, and a moderate amount of sclerosis (Figs. 2, A and 3, A). The sinuses, however, continued to drain actively, with a positive culture of *Staphylococcus aureus hemolyticus*.

The patient was given 500,000 units of penicillin beginning on Oct. 20. The response was dramatic. The drainage decreased rapidly and the sinuses diminished in size; the pain disappeared, and in three weeks the patient was able to be up and about. One small sinus over the right wrist continued to drain intermittently.

The patient returned to the clinic on April 26, 1944, and on that date all the sinuses had closed, the temperature had been normal for three months, and he had returned to school and resumed all normal activities. Roentgenograms showed a rather marked sclerosis of bone in the involved areas; there had been no extension of the destructive process and no sequestration (Figs. 2, B and 3, B).

Comment: In this case the multiple bone lesions were foci of hematogenous osteomyelitis of approximately the same age, showing no great tendency toward sequestration. Adequate surgical drainage had been done, and the patient showed a dramatic and remarkable response to the penicillin. It was of interest to us that the progress of the infection was arrested. There was no extension of the osteomyelitic process, no large amount of

Fig. 5A. Case IV. Roentgenograms taken Jan. 12, 1944, showing necrosis and sequestration of the body of the astragalus with an old unhealed fracture of the neck of the astragalus, osteoporosis, and definite bone destruction in the adjacent scaphoid and cuboid.

involucrum formed, and there was definite evidence of early recalcification of the infected areas.

CASE III: Mrs. G. P., a 56-year-old woman, came to the clinic Feb. 24, 1944, with a painful right thigh. Three weeks previously a carbuncle on the right shoulder had been excised and the area skin-grafted. The patient was first seen in consultation at another hospital. On examination she appeared acutely ill; her temperature was 102°, and white blood count 9,800. Blood culture was positive for *Staphylococcus aureus*. Roentgenographic examination of the right femur showed an extensive osteomyelitis with bone destruction involving the proximal one-third of the femur and elevation of the periosteum on the inner surface (Fig. 4A).

The patient was given 5,000 units of penicillin every two hours until a total of 1,000,000 units had been given. The third day after the penicillin therapy was instituted, the temperature dropped to 98.6° and remained normal thereafter. Pain and tenderness disappeared, and the patient was discharged on March 17. She returned to the clinic for check-up roentgenograms on April 10,1944 (Fig. 4B). Films at that time showed extensive bone replacement and callus deposition along the line of periosteal reaction. The patient remained clinically cured.

Comment: This patient did not have surgical drainage. She had an acute hematogenous osteomyelitis with a positive blood culture. Clinical cure was achieved, and the roentgenograms showed that the infection had been checked, that no sequestration or extension occurred; there was no involucrum, and the involved areas showed a tendency toward rapid recalcification.

CASE IV: C. L., a 43-year-old man, was admitted to the clinic Oct. 3, 1943, having fallen from a second-story window. On examination he showed a compound fracture-dislocation of the left astrag-

Fig. 5B. Case IV. Roentgenograms taken April 24, 1944. Surgical removal of the body of the astragalus has been done, and an early calcaneotibial fusion obtained. There is an increase in the osteoporosis of the adjacent bones, but there is no evidence of increased destruction and no sequestration.

alus. At the time he was first seen, the fracture was eight hours old. Immediate débridement and reduction were done, sulfanilamide being placed in the wound. Sulfathiazole was also given by mouth. On the sixth day, however, signs of local infection developed about the fracture. The sutures were removed and a large quantity of purulent material was evacuated, culture of which showed gram-positive cocci in pairs, bunches, and short chains, as well as gram-positive bacilli. The temperature at the time of onset was 101°. Following adequate drainage of the infection, the temperature returned to 98.6° and remained normal throughout the subsequent period of treatment, although sinuses about the wound continued to drain. The reduction of the astragalus was maintained, but roentgenograms taken on Dec. 13 showed definite necrosis of the body of the bone. The wounds continued to drain and the patient remained afebrile. Cultures from the wound continued to show a mixed infection of *Staphylococcus* and gram-positive bacilli.

The patient was given a course of 500,000 units of penicillin over a period from Dec. 21 to Dec. 27, but there was no change in the character of the drainage other than that the *Staphylococcus aureus hemolyticus* at the end of the penicillin course was cultured as non-hemolytic *Staphylococcus aureus*. It was then decided to do an astragalectomy and a calcaneotibial fusion, in spite of the infection, and this was done on Feb. 21, 1944. The patient was given penicillin, 10,000 units every two hours, for two days preoperatively, and penicillin was continued postoperatively until the seventh day, 1,000,000 units being given over this period. Following the operation, the temperature rose daily to 101°. On the twelfth day, however, it returned to 98.6° and remained normal thereafter.

Roentgenograms taken on Jan. 12, 1944 (Fig. 5A), after the first course of penicillin, showed sequestration of the body of the astragalus and a considerable amount of destruction involving its neck. There was a definite loss of ankle joint space, with some demineralization of the distal end of the tibia. In addition to involvement of the neck of the astragalus, there was involvement of all of the tarsal bones, which showed demineralization and bone destruction. Roentgenograms taken postoperatively showed no evidence of extension of the infection. The sequestrum had been completely removed surgically and a calcaneotibial fusion had been done. There was no further sequestration, nor was there any further involvement of the adjacent tarsal bones (Fig. 5B). The clinical course was excellent.

Comment: This case illustrates the possible use of penicillin in elective surgery done in infected fields with no spread of the infection. In this particular instance a rather extensive operation was done, of a type which, in the past under similar circumstances, would be frequently followed by such extensive spread as to amount to a surgical disaster.

CASE V: C. J. E., an 11-year-old boy, was admitted to the Baptist Memorial Hospital with a history of infection of the lower portion of the right

tibia of seven weeks' duration. The area had been incised and drained twice before admission, and pus had been evacuated. The right leg showed generalized swelling of the lower two-thirds, with a definite area of fluctuation proximal to the medial malleolus of the tibia. There were two small incisions with purulent drainage from each. The temperature on admission was 101°, the white blood count was 11,600, the blood culture was negative, and the wound culture showed *Staphylococcus aureus*.

Penicillin therapy was instituted immediately, 5,000 units being given every two hours for sixteen days, representing a total of 920,000 units. On April 21, two days after admission, the soft-tissue abscess was incised and drained, vaseline gauze was packed in the wound, and a cast was applied. On the same day the patient was given 500 c.c. of whole blood. The temperature continued to show daily elevations until the thirteenth day, when it returned to 98.6°, remaining normal thereafter.

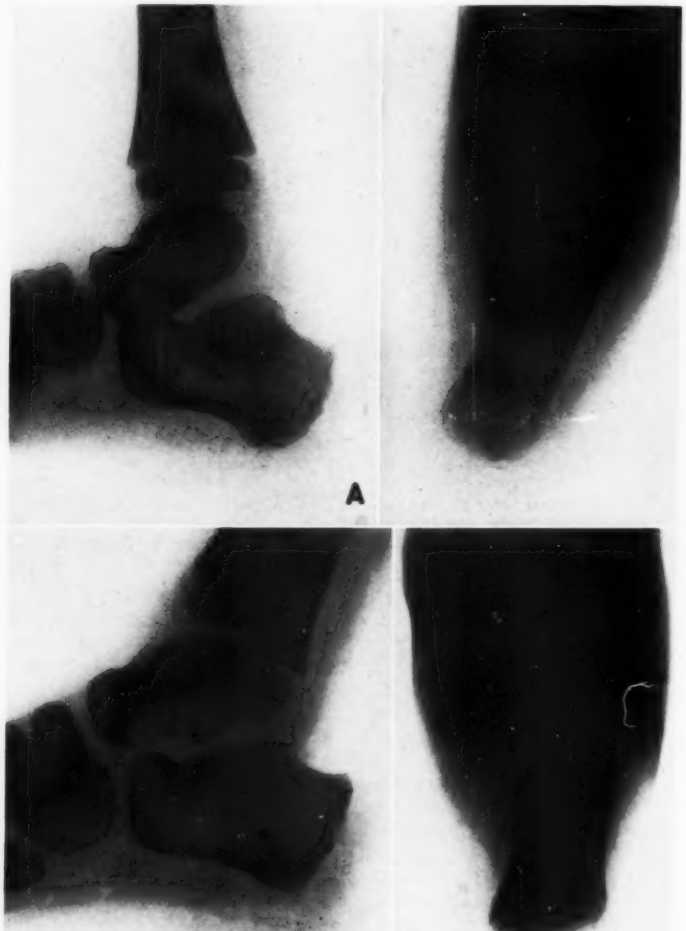

Fig. 6. Case V. A. Roentgenograms taken April 20, 1944, showing extensive osteomyelitis involving the lower metaphysis of the right tibia, with extensive destruction, apparent early sequestration of the lateral cortex, and early involucrum formation. B. Roentgenograms taken May 6, 1944. There is no further sequestration, no further extension of the osteomyelitic process, and no increase in the involucrum. Early recalcification of the involved areas has occurred.

Roentgenograms taken at the time of admission

Fig. 7. Case VI. A. Roentgenograms taken Sept. 1, 1943, showing an early osteomyelitis involving the posterior portion of the os calcis, with small areas of decreased density. B. Roentgenograms taken April 13, 1944, showing recalcification in the posterior portion of the os calcis previously involved by osteomyelitis. This recalcification is slightly denser than the normal surrounding bone. There is no evidence of sequestration or extension of the process.

(April 20) showed an area of destruction involving the lower metaphysis of the tibia with apparent early sequestration of the lateral cortex (Fig. 6, A). On May 6, seventeen days after penicillin treatment was instituted, the cast was removed. The incised area was found to have filled in with granulation tissue and no definite sinus was present. Roentgenograms of this date showed no further extension of the osteomyelitis, and the area of cortical bone which had appeared to be sequestrating showed an apparent arrest of the sequestrating process. There was little evidence of involucrum, and the areas of bone destruction showed an early recalcification (Fig. 6, B).

CASE VI: F. J. R., a 5-year-old boy, was admitted to the clinic on Aug. 25, 1943, with a painful right heel with fever. One month prior to admission he had had furuncles on both thighs, eight of these having been opened at one time. He was given a course of sulfa drugs following the opening of the initial lesions, but he continued to show successive furunculosis. Five days before admission a large furuncle appeared on the left thigh, and simultaneously the right heel became painful, causing a limp. Three days before admission fever developed. Two days before admission an attempt was made to drain the heel, but no pus was found. On examination the heel was tender to pressure but there was no evidence of localized infection in this region. The white blood count was 8,200, with 56 per cent polymorphonuclear cells. The temperature was 103° on admission, and showed daily afternoon rises to 103° thereafter.

The patient remained in the hospital for four days, during which time he was given sulfathiazole. The leg was placed in a plaster cast without drainage, and he was then transferred to another hospital for penicillin therapy. Roentgenograms taken on Sept. 1, 1943, ten days after the onset of symptoms, showed a definite area of osteomyelitis of the posterior portion of the right os calcis (Fig. 7, A). The patient was given a course of 1,000,000 units of penicillin intramuscularly, 10,000 units every three hours. Three days after the institution of this treatment the temperature returned to 98.6° and remained normal thereafter. The leg was kept in a plaster boot cast for two months and no further symptoms developed.

The patient returned to this clinic April 13, 1944, for additional films. On this date he was clinically well, and the roentgenograms showed no evidence of sequestration or extension of the infectious process; there was recalcification throughout the previously involved area (Fig. 7, B).

Comment: This case represents an acute hematogenous osteomyelitis of the os calcis apparently cured without surgical drainage, the roentgenograms showing no extension of the infection or sequestration in an area of cancellous bone prone to show sequestration and extension.

CONCLUSIONS

The case summaries presented represent several types of bone infection in which we feel that definite improvement followed the use of penicillin. It is our opinion that, in general, the treatment of bone infections with penicillin has been satisfactory. The response varies in individual cases. In most instances the period of active infection was considerably decreased. In those cases which showed a favorable response to penicillin, clinical improvement preceded any roentgenographic evidence of healing. The roentgenographic evidence which we have seen in our cases is as follows:

(1) Apparent arrest of the spread of the infection with little or no sequestration of bone and little or no involucrum.

(2) Positive evidence of healing, in the form of a reactive recalcification of the affected areas, the recalcification appearing throughout the cortex of the bone and approaching the normal architecture of the bone much more closely than does the ordinary involucrum in osteomyelitis. The area of recalcification was of slightly greater density than normal bone.

(3) Since the progress of the infection in these cases was apparently arrested and the reparative process began before extensive spread, sequestration, and involucrum had appeared, the resultant end sclerosis was less than has been commonly seen in extensive osteomyelitis which has run the normal evolutionary course.

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Lethal Dose Studies with X-Rays[1]

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I. INTRODUCTION

BIOLOGICAL evaluation is as indispensable in study of the therapeutic potentiality of radiations as in that of drugs, hormones, or vitamins. This is particularly true of radiations of short wave length, such as x-rays, which are known to produce permanent and irreversible changes.

It is well known that there are two fundamentals upon which the evaluation of any therapeutic agent is based (Sollmann, 4): its local action and its toxicity when applied to the entire animal. Studies of the latter type are also called lethal dose studies. In the case of x-rays, relatively satisfactory data are available concerning the local action on various tissues and in different animal species (Ellinger, 2). No such facts have been established, however, for the toxicity of x-rays in general body irradiation. The literature, it is true, contains scattered references to the lethal effect of whole body irradiation for a variety of animals, but most of these data have been obtained under conditions which preclude any accurate evaluation of the results.

A systematic study of lethal doses of x-rays seems, therefore, to be desirable from several points of view. In the first place, investigation along this line promises a better understanding of some of the already known effects of x-rays. This may well lead to improvement in the application of radiation therapy and may even open new fields for this form of treatment. In the second place, such studies may furnish data upon which to base a more effective treatment of generalized malignant growth, with less accompanying toxemia. Finally, a more detailed knowledge of lethal doses of x-rays will be of value in the use of artificial radioactive substances as therapeutic agents. The main purpose of lethal dose studies with x-rays is, therefore, (1) to establish lethal doses for various animal species under well defined conditions of irradiation, which will make the data thus obtained generally applicable; (2) if at all possible, to relate lethal doses to body weight or body volume or, if there is no such relationship, to consider the problem of species specificity; (3) to establish the percentage of the lethal dose necessary to produce destructive effects on organs and tumors for various animal species; (4) to establish correlation factors applicable to man, on the basis of lethal doses for animals.

The terms "lethal dose" and "sublethal dose" have been used in experimental studies on the effects of radiation with a great variety of meanings. As used throughout our investigations, "*sublethal dose*" designates any amount of radiation producing no mortality within a given period of time, while "*lethal dose*" designates any amount of radiation producing a certain percentage of fatalities within a given period of time. It is obvious that without the inclusion of a time factor these terms are meaningless. On the basis of previous experience (Ellinger, 1), therefore, we have chosen twenty-eight days as the total observation period and fourteen days ± 20 per cent as the time factor for the definition of lethal dose.

Since the definition of "lethal dose" as given above makes it evident that there is not a single lethal dose but rather various lethal doses, further subdivision of this term becomes necessary. These subdivisions will be made in conformity with the nomenclature used in recording drug action (Munch and Garlough, 3). Thus in a general study of lethal doses we must differentiate:

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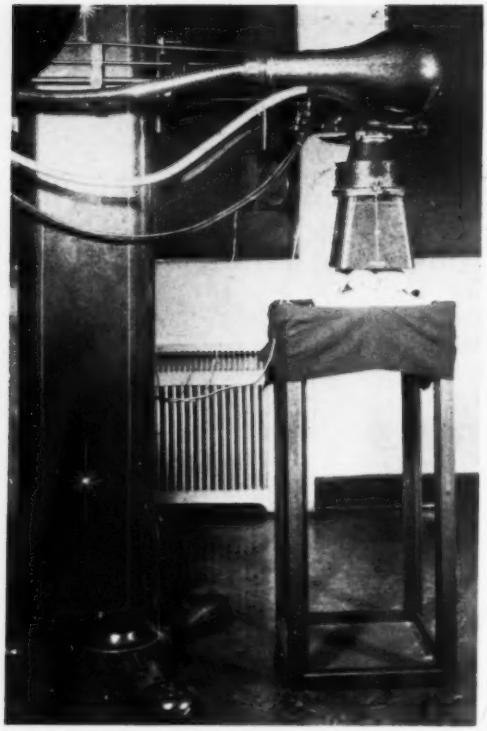


Fig. 1. Method of exposure of animals to radiation.

A. Sublethal Doses

(1) Ineffective Doses: Doses producing no change in the normal appearance or organ function.

(2) Minimum Effective Doses (MED): The amount of radiation producing changes in the appearance or proper organ function of the irradiated animals.

B. Lethal Doses

(1) Minimum Lethal Dose (MLD): The amount of radiation producing a few (at least 10 per cent) fatalities.

(2) Lethal Doses of Various Percentage Mortality ($LD^{}$)[2]: The use of the 50 per cent lethal dose, LD^{50}, has been proposed by Trevan (5) as especially suitable for comparative studies.

[2] The percentage designated by an index figure

(3) The Absolute Lethal Dose (ALD): The amount of radiation invariably producing death of all animals within a given period of time.

II. DETERMINATION OF THE LETHAL DOSE FOR MICE

Previous investigations (8, 9) have established the lethal dose of x-rays for a small cold-blooded animal, the common goldfish (*Carassius auratus*). The present work represents an extension of these studies to a small warm-blooded animal, the white laboratory mouse.

Technic: The radiation factors employed were as follows: 200 kv.p.; 10 ma.; 0.13 mm. Sn, 0.25 mm. Cu, and 1.0 mm. Al filtration, corresponding to a half-value layer of 1.25 mm. Cu. The intensity of radiation was 15.6 r per minute. The distance from the target to the animal container was 50 cm. in all experiments. The total field size was 20 × 20 cm. The doses ranged from 200 to 1,000 r (measured in air) and were given in every instance in one continuous exposure.

A total of 200 male white mice were used in these experiments, 44 of which served as unirradiated controls. The average weight of the animals at the time of exposure was 20 gm. ± 15 per cent.

For each exposure 6 mice were used, each being placed in a small paper bag which was then inserted in a small linen bag. It was thus possible to expose the animals under most natural conditions, without the use of any anesthetic which might have influenced the susceptibility to irradiation. The bags containing the mice were placed on a wooden frame 118 cm. high, the top of which measured 44 × 44 cm. The opening of the frame was covered with a sheet of linen. On this sheet, bags of rice 10 cm. high were placed as a constant scattering medium, as shown in Figure 1. Each exposed lot of mice was kept in one cage. The animals were fed with Purina dog chow and vegetables and kept under daily observation for at least twenty-eight days.

General Appearance of Irradiated Mice: For two to five days after exposure (de-

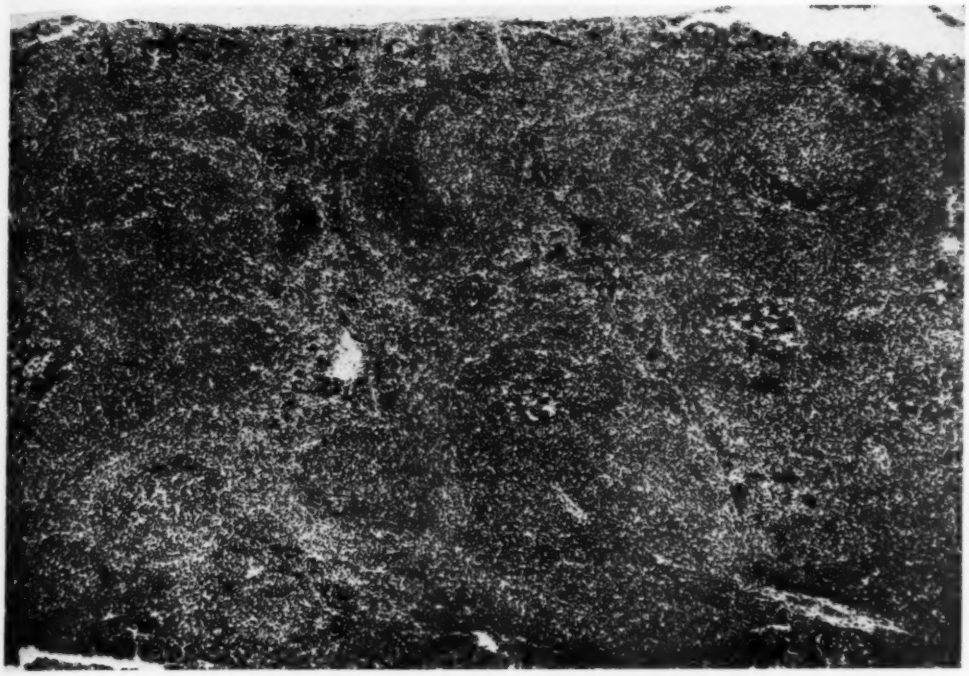
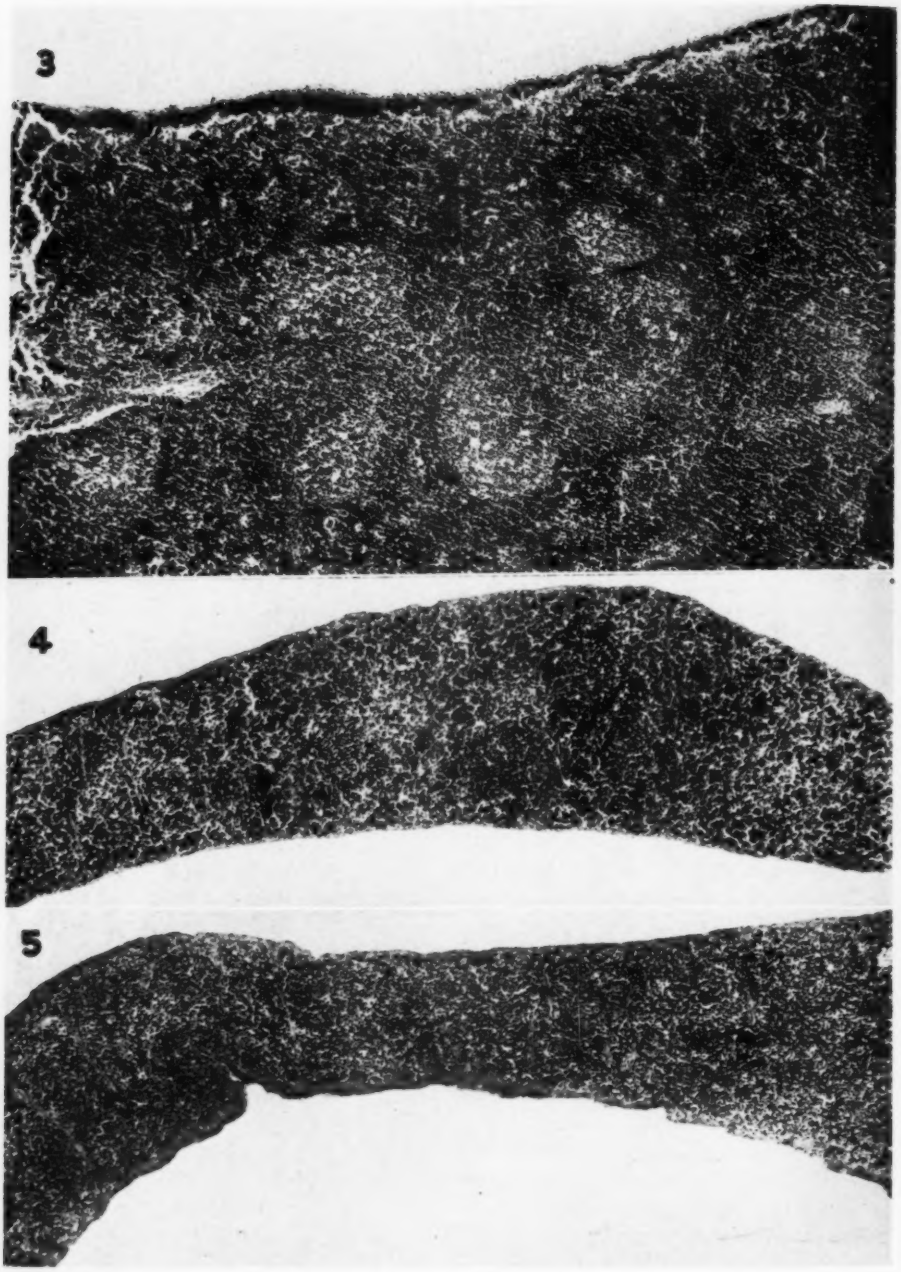


Fig. 2. Spleen of a normal mouse, showing the distinctly outlined malpighian bodies. ×60.

pending on the dose) there was a latent period in which the appearance of the treated mice differed in no way from that of the unirradiated controls. After five days, mice exposed to doses between 200 and 600 r in air usually exhibited shaggy fur, loss of appetite, and diarrhea. The first fatalities coincided with the appearance of these symptoms. Surviving animals usually regained normal appearance between the fourteenth and twentieth day after exposure. In the animals exposed to doses of 800 or 1,000 r in air, the first fatalities occurred, without prodromal signs or symptoms, on the second day after exposure. Some animals, however, appeared severely ill on the third or fourth day after irradiation, exhibiting somnolence, dyspnea, and diarrhea. These symptoms were followed by death in a large percentage of instances.

Postmortem Examinations: Postmortem examinations revealed severe injury to the hematopoietic tissues, the changes being most conspicuous in the spleen and bone marrow. With increasing doses, atrophy and shrinkage of the lymphatic tissues increased. With the highest doses, the spleen was reduced to about one-third of the normal average size.

Histologic examinations revealed progressive depletion of the lymphatic elements of the bone marrow and spleen in direct proportion to the doses employed (Figs. 2–9). The malpighian bodies of the spleen, in particular, permitted some quantitative evaluation of the radiation effect. Following the application of 200 r the malpighian bodies were distinctly outlined but showed a reduction in white blood elements on the seventh to the twelfth day after exposure. On the ninth day after exposure to 600 r in air there were only a few cells remaining and on the fourth day after exposure to 1,000 r in air not even traces of malpighian bodies could be found (Fig. 5). It seems noteworthy that the sternal bone marrow was practically devoid of white elements on the ninth day after the application of 600 r

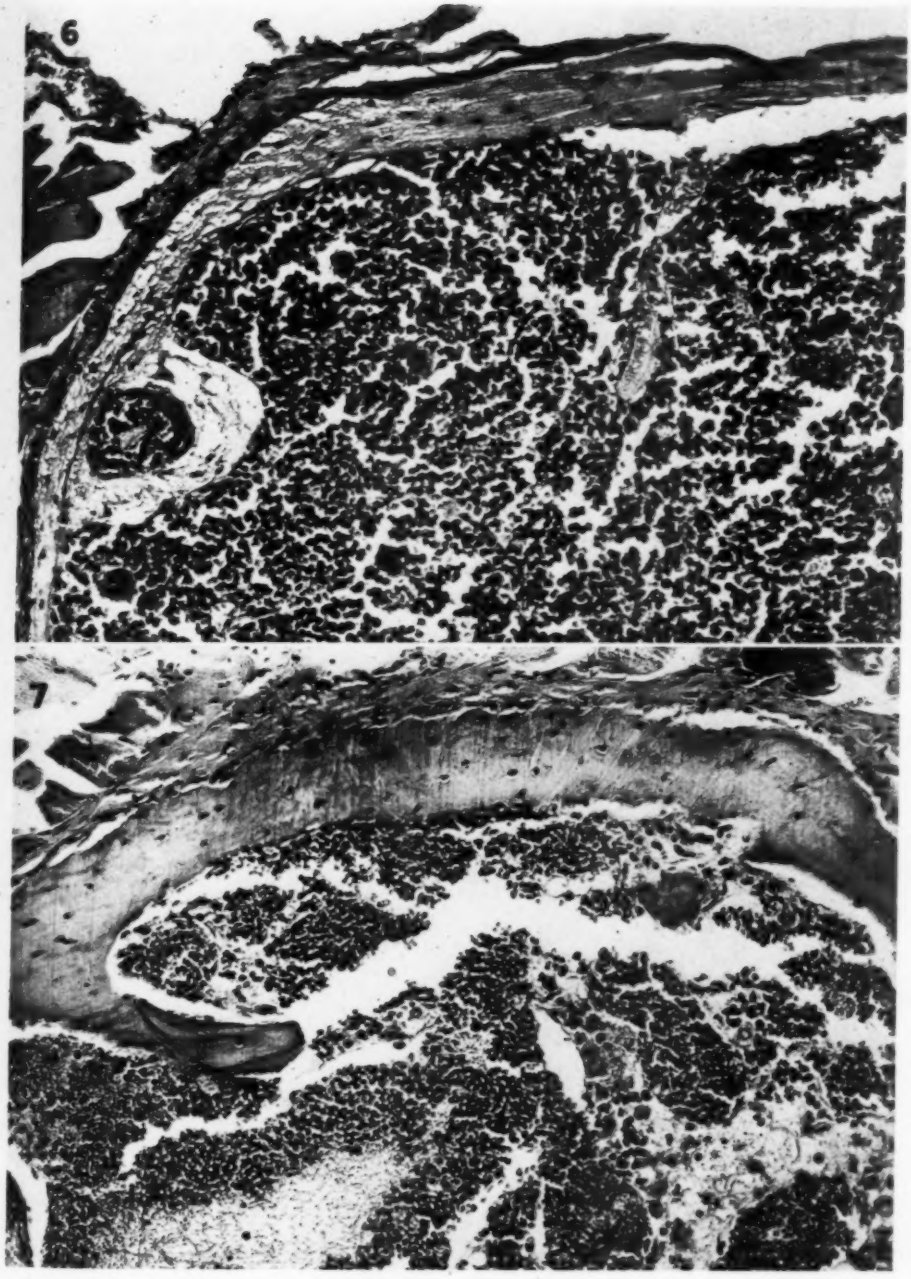


Figs. 3–5. Effects of radiation on the spleen.

Fig. 3. Spleen of a mouse which died on the seventh day after exposure to 200 r in air. The malpighian bodies are distinctly outlined but the white blood elements are reduced. ×60.

Fig. 4. Spleen of a mouse which died on the ninth day after exposure to 600 r in air. Only a few remnants of malpighian bodies are visible. Notice the considerable shrinkage of the spleen in comparison with Figure 2. ×60.

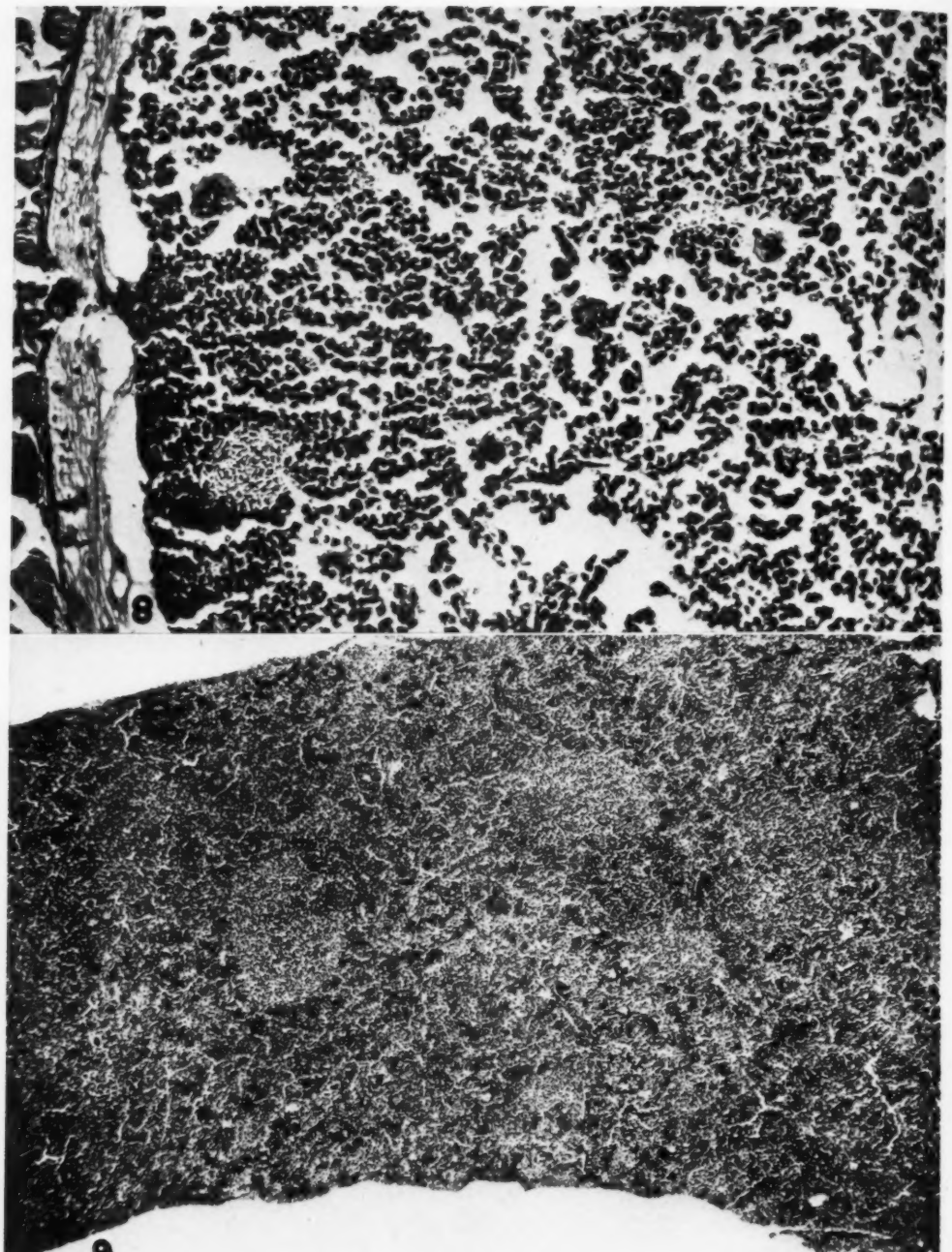
Fig. 5. Spleen of a mouse which died on the fourth day after exposure to 1,000 r in air. Not even traces of malpighian bodies are left. Further progress in shrinkage. ×60.



Figs. 6 and 7. Effect of radiation on the bone marrow.

Fig. 6. Normal sternal bone marrow of a mouse. ×300.

Fig. 7. Sternal bone marrow of a mouse which died on the ninth day after exposure to 600 r in air. The bone marrow is almost devoid of white elements. ×300.



Figs. 8 and 9. Bone marrow and spleen.

Fig. 8. Sternal bone marrow of a mouse killed twenty-eight days after exposure to 600 r in air. Almost normal appearance in comparison with Figure 6. ×300.

Fig. 9. Spleen of a mouse killed twenty-eight days after exposure to 600 r in air. While the bone marrow of the same animal (Fig. 8) appears almost normal, the malpighian bodies of the spleen, when compared with those of a normal spleen (Fig. 2), appear less distinctly outlined, thus indicating a slower recuperative power of the spleen. ×60.

in air. The fact that, in spite of this, many animals recovered, while none recovered when the malpighian bodies were destroyed, confirms the general opinion that the bone marrow is characterized by greater sensitivity and power of recuperation than the spleen. In support of this statement, it may be mentioned that, in a mouse killed on the twenty-eighth day after exposure to 600 r, the bone marrow appeared entirely normal, while the malpighian bodies of the spleen were less distinctly outlined than in the unirradiated control (Figs. 8 and 9). Mice killed 181 days after exposure to 200 r in air showed an entirely normal appearance of spleen and bone marrow.

Besides the changes in the spleen, hemorrhages in the small intestine, and less frequently along the greater curvature of the stomach, were the most conspicuous gross anatomical findings. Details of the postmortem findings in other organs will be considered in a later publication.

Relationship between X-Ray Doses and Mortality: For the study of the lethal effect of x-rays, 24 animals were exposed for each dose, except the smallest—200 r in air—for which 41 mice were employed. The number of dead animals was recorded daily up to the twenty-eighth day. No mortality was observed among the unirradiated controls within this period.

A graphic presentation of the results obtained is given in Figure 10. The abscissa denotes the days after exposure, while the ordinate denotes percentage mortality. The curve for each dose is the *lethal dose curve*. As can be seen, the mortality increased progressively as the doses were raised from 200 to 1,000 r in air. While with a dose of 200 r a maximum mortality rate of 10 per cent within twenty-eight days was obtained, the mortality reached 100 per cent within fourteen days after the application of 1,000 r.

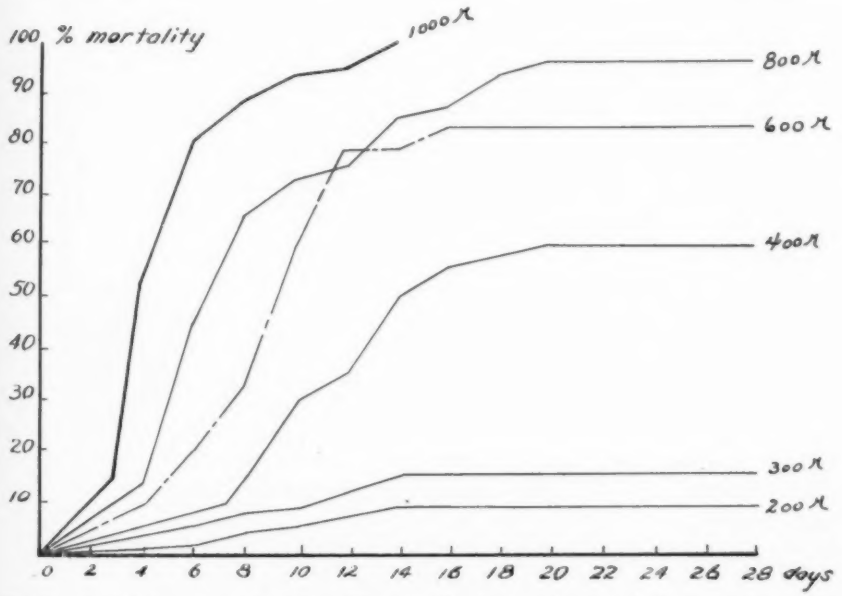


Fig. 10. Lethal dose curves for mice. The mortality increased progressively as the doses were raised from 200 to 1,000 r in air.

In accordance with the definitions given above (p. 126), *200 r in air* represents, under our conditions of exposure, *the minimum lethal dose* (*MLD*), while *1,000 r in air* represents the *absolute lethal dose* (*ALD*).

In order to compare the lethal effect of x-rays in various animal species and under different conditions of irradiation, it is necessary to plot *a mortality curve*. This curve is obtained by plotting the doses of x-rays in r on the abscissa and using the percentage mortality as the ordinate. Figure 11 is the mortality curve for mice on the fourteenth day after exposure. As in the study of the lethal effect of x-rays on single cells (10) and in studies using goldfish as the test object (8, 9), the relationship between the dose and the effect has been found to follow an S-shaped curve.

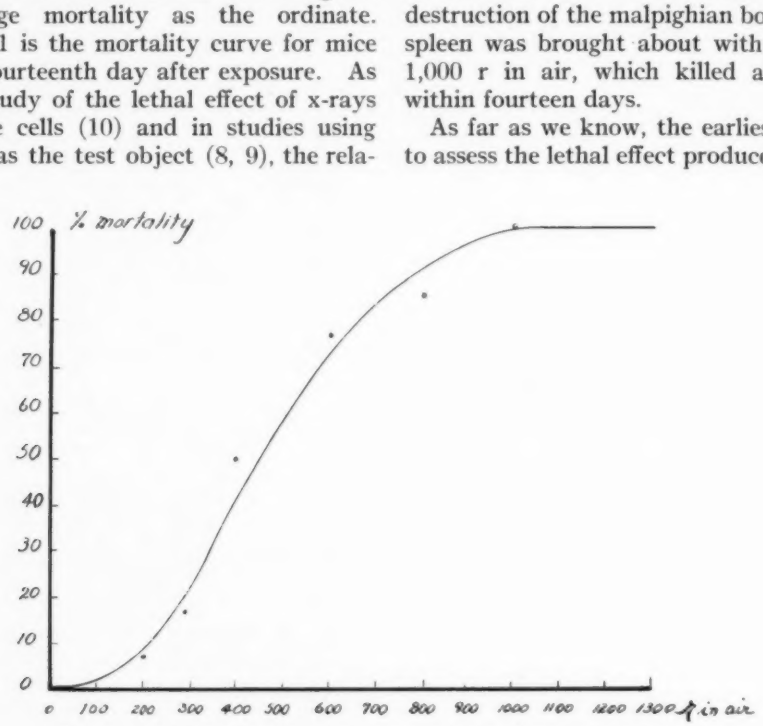


Fig. 11. Mortality curve for mice, fourteenth day after exposure to x-rays.

Discussion

The literature contains some references to the lethal doses of x-rays for mice, but because of different conditions of investigation little of this material is comparable with that presented in this communication. As early as 1906, Krause and Ziegler (12) stated that "the lethal dose of x-ray for mice is obtained when the malpighian bodies of the spleen are entirely destroyed. In this case the damage done to the lymph nodes and to the bone marrow is of such a nature that recuperation of the blood-forming tissue is precluded." The observations presented here amply confirm this statement. At the same time, our findings permit the correlation of this biologically established lethal dose with its physical equivalent expressed in r. It may be recalled that in our series complete destruction of the malpighian bodies of the spleen was brought about with a dose of 1,000 r in air, which killed all animals within fourteen days.

As far as we know, the earliest attempt to assess the lethal effect produced by total body irradiation in mice was made in 1912, when Meyer and Ritter (15) tried to build up a "mouse unit" as a biologic measure in radiology analogous to the "frog unit" used in the assay of digitalis preparations in experimental pharmacology. Even though their data are in no way comparable, because of the uncertainty of the irradiation factors, their results are interesting. They showed that with increasing doses of x-rays there was a steadily decreasing latent period between the time of exposure and the earliest occurrence of death. They also demonstrated that, as the dose of x-rays was increased, the average life span of the 20 mice exposed to each dose decreased. Increasing the dose of x-rays beyond that

which killed all 20 animals within fourteen days, they were able to show further acceleration of the processes leading to death of the irradiated animals, so that with the highest doses applied, all died within three days.

Investigations performed under well defined conditions of irradiation have confirmed these early observations. Sugiura (17) irradiated mice with x-rays generated at 200 kv., 30 ma., with 0.5 mm. Cu and 1.6 mm. Al filtration. He found that 1,000 r in air killed 12 mice within eight days and 1,500 r given to a total of 8 mice killed 2 on the third, 4 on the fourth, and the remaining 2 on the fifth day. Further increase of the dose, up to 2,830 r, resulted in the death of 2 mice on the third day and of the remaining 6 mice exposed to this dose on the fourth day. Similarly, Goldfeder (11) observed that mice exposed to 4,000 r in air (factors: 200 kv., 6 ma., 1.0 mm. Al filtration) died within four or five days.

Recent studies by Barnes and Furth (6) confirm these observations. These authors irradiated mice with doses ranging from 800 up to 6,000 r in air (factors: 200 kv., 15 ma., 3.0 mm. Al filtration, distance 25 cm.; or 200 kv., 15 ma., 1.0 mm. Cu and 1.0 mm. Al filtration, distance 50 cm.). Study of the bone marrow of the irradiated animals showed that "the larger the dose, the earlier was the decrease of hematopoietic cells in the directly irradiated marrow."

These observations of a shortened latent period and life span following an increase in dose over the ALD are important, for they seem to reveal a species difference between mammals and fish, since in our previous studies with goldfish (8) increase of the ALD of 1,500 r in air up to 10,000 r shortened neither the latent period nor the life span.

Lawrence and Tennant (13) obtained data on the ALD for mice irradiated with x-rays under defined conditions (factors: 200 kv., 0.2 mm. Cu and 1.0 mm. Al filtration). They found that 14 mice died within fourteen days after exposure to 704 r in air. After exposure to 1,000 r in air, 10 mice died within eight days. The mice had been exposed in flat cardboard boxes.

Clarkson, Mayneord, and Parsons (7) irradiated 20 mice with 1,200 r in air (factors: 150 kv., 4.0 ma., 0.3 mm. Cu filtration). The animals died within five days, exhibiting severe diarrhea. Out of 10 mice exposed to 1,000 r, 4 died within eleven days. For irradiation the animals were placed in a wooden box, the lid of which was 9 mm. thick, for which an allowance of 4.5 per cent in absorption was made.

Tang (18) irradiated an unstated number of mice with doses of 500, 700, and 800 r in air (factors: 200 kv., 4 ma., 0.5 mm. Cu filtration). Of the mice exposed to 500 r, 80 per cent survived sixty days, while all of the mice exposed to 700 r died within fourteen days, and those exposed to 800 r within nine days.

Further data of interest have been reported by Liu, Snyder, and Enders (14). These authors irradiated 63 mice in metal containers. The dose was 500 r in air (factors: 200 kv., 8 ma., 0.5 mm. Cu filtration) and 22 per cent of the mice died within fourteen days.

Sugiura (17) found that 750 r in air killed 16 animals within eighteen days, while 1,000 r in air killed 12 within eight days. In his paper, some data on the MLD are also contained. He found that after exposure to 350 r in air all 12 exposed animals survived, while irradiation with 400 r caused the death of 2 out of 22 animals on the fourteenth day, and of one each on the twentieth and twenty-fifth days after exposure.

Further observations on the MLD are contained in the thesis of Wagner (19), who irradiated mice with doses of 275 and 330 r in air (factors: 200 kv., 2.8 ma., 5.0 mm. Al filtration, HVL 0.37 mm. Cu, distance 46 cm.). While a dose of 275 r appeared entirely harmless, the application of 330 r caused the death of some mice.

Lawrence and Tennant (13) found that mice exposed to 400 r in air survived, while after application of 450 r one of 10 mice died within eleven days.

The recent observations of Barnes and

Furth (6) concerning the effect of doses between 100 and 1,000 r in air on the leukocyte level of the blood of mice after total body irradiation are of great interest with respect to studies on the MLD. The graphic presentation of their results shows that "the number of leukocytes in the circulating blood decreases in direct proportion to the dose employed. With larger doses the drop in leukocytes is evident one day after irradiation and reaches its maximum approximately six days after exposure with a gradual return to normal or above normal if the animals survive." They state, furthermore, that "mice almost invariably die following exposure to 1,000 r." Since their graph shows that within twenty days after exposure to 200 r restoration of the leukocyte level to values above normal takes place, these studies are an interesting confirmation of and supplement to our own studies on the MLD and ALD for mice as reported in this paper.

We should now consider the question of the *minimum effective dose* (MED). Careful studies in this field have recently been published by Nettleship (16). He exposed C3H mice to 50 r in air (factors: 200 kv., 20 ma., 0.5 mm. Cu and 1.06 mm. Al filtration, 105.3 cm. distance; intensity 8 r per min.), which produced the following tissue changes: (*a*) swelling and eosinophilic staining of the cell cytoplasm with reduced nuclear staining; later slight hyperchromia of the cell nucleus and final return to normal; (*b*) destruction of cells within the lymph node follicles, followed by a mild hyperplasia; (*c*) an altered blood picture consisting of momentary leukocytosis turning within eight to twelve hours into a mild but persistent lymphopenia. These changes, Nettleship concludes, "represent only small deviations from the normal and they may be regarded as threshold irradiation effects."

In summary it can be said that, with due allowance for the variety of irradiation conditions and the small number of animals used in some recorded experiments, the data presented in this paper seem to be well supported by observations in other quarters. The review of the literature clearly emphasizes, however, the necessity of standardized irradiation conditions for studies along this line. In order to secure universally applicable data it seems to be necessary, *first*, to use a highly penetrating radiation in order to accomplish homogeneous distribution of radiation throughout the entire animal body; *second*, to irradiate with full utilization of back-scatter.

Observation of this second postulate is necessary to make studies in different animal species comparable. Since a small animal offers a smaller scattering medium than is the case with a larger, omission of this consideration may introduce an error in the evaluation of lethal dose studies, where animals of various sizes are used. It is for this reason that we have included rice bags as a scattering medium in our standard procedure.

Summary

A standard set-up for the determination of lethal doses of x-rays in mammals has been described. Mice have been used as a test object. As in previous studies with goldfish, an increasing mortality rate has been found with increasing doses of x-rays.

Under the described experimental conditions, the minimal lethal dose (MLD) for radiation of HVL 1.25 mm. Cu has been found to be 200 r in air, and the absolute lethal dose (ALD) 1,000 r in air.

Correlation of the lethal effect of x-rays with the destruction of the malpighian bodies of the spleen has been demonstrated.

The relationship between doses of x-rays and lethal effect in mice has been found to follow an S-shaped curve, similar to that obtained in investigations with goldfish.

The importance of a standard procedure for studies on the lethal effect of x-rays in laboratory animals is discussed.

III. INFLUENCE OF BACK-SCATTER ON LETHAL DOSE FOR MICE

Mention has been made above of the importance of back-scatter for accurate

lethal dose determination. The investigations about to be reported were therefore undertaken to obtain some information concerning the extent to which scattering influences the lethal dose of x-rays for mice under the conditions previously employed.

Technic: The radiation factors were the same as those used in determining the lethal dose (see page 126) and the set-up was the same except that rice bags were not used. Doses ranging between 400 and 1,500 r in air were given in one session.

gressive destruction of the malpighian bodies of the spleen. The spleen of a mouse dying on the sixth day after exposure to 1,500 r in air was almost completely devoid of malpighian bodies, while that of an animal dying on the tenth day after exposure to 800 r (maximum lethal rate 36 per cent) showed definite remnants of malpighian bodies. The spleen of a mouse surviving an exposure to 800 r in air for seventy-seven days appeared normal.

Relationship between X-Ray Doses and Mortality Rate: For the study of the lethal

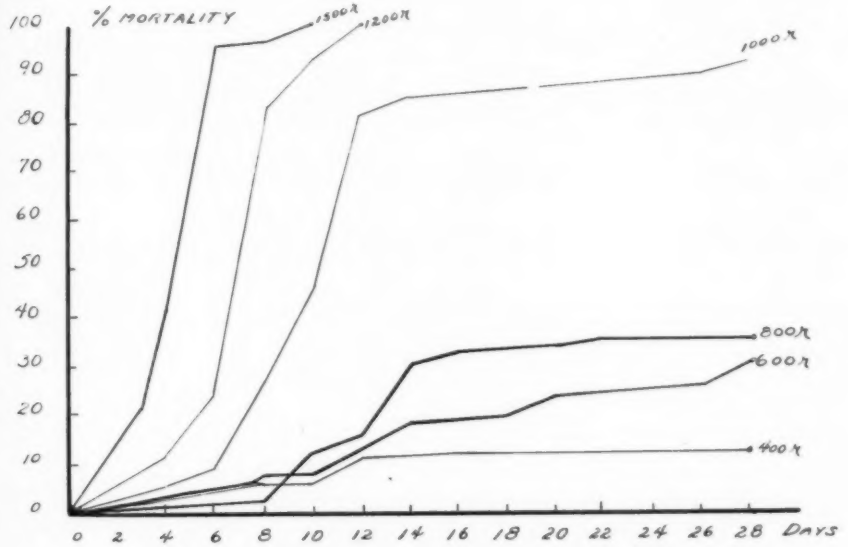


Fig. 12. Lethal dose curves for mice irradiated free in air.

A total of 155 white male mice were used, 36 of which served as unirradiated controls.

General Appearance of Irradiated Mice and Postmortem Examinations: As in the previous investigations, there was a latent period of from two to five days (depending on the dose) before any change in the behavior of the mice was noticed. Their general appearance was exactly the same as in the preceding series.

The autopsy findings did not differ from those described above. Grossly the changes in the spleen, small intestine, and stomach were the most conspicuous. Histologic examination revealed the same pro-

effects of x-rays, 18 mice were exposed for each dose except for the dose of 1,000 r in air, where 22 mice were used. The number of dead animals was recorded daily up to the twenty-eighth day. No mortality was observed among the unirradiated controls within this period.

A graphic presentation of the results thus obtained is given in Figure 12. As in the previous investigation, the abscissa denotes the days after exposure, while the ordinate denotes percentage mortality. With increasing doses, from 400 up to 1,200 r in air, the mortality increased accordingly. Further increase of the x-ray dose

up to 1,500 r in air produced a shortening of the latent period and acceleration of the processes leading to death. While the first death occurred on the third day after exposure to 1,200 r in air, and all animals died within eleven days, exposure to 1,500 r shortened the latent period to two days, and all the animals were dead within nine days. In conformity with the previously adopted designation, *400 r in air represents in this series the minimum lethal dose* (MLD), while *1,200 r in air is the absolute lethal dose* (*ALD*).

Figure 13 is *the mortality curve for mice irradiated free in air* for the fourteenth day after irradiation, obtained by plotting on the abscissa the doses of x-rays and using the percentage mortality as ordinate values. As can be seen, the relationship between dosage and mortality follows an S-shaped curve.

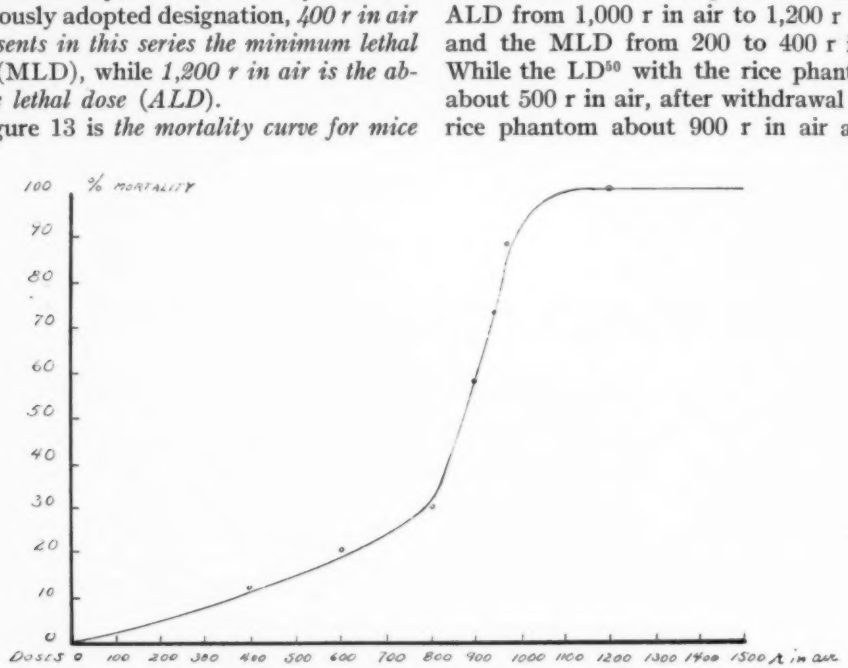


Fig. 13. Mortality curve for mice irradiated free in air.

Assay of the Influence of Back-Scatter on the Lethal Dose: For the determination of the influence of the scattering medium (rice bags) on the lethal effect in mice, Figure 14 was prepared. In this graph the ordinate shows percentage mortality, while the abscissa values are r in air. The broken line represents the mortality curve as obtained in the previous investigations, where the irradiation took place on top of the rice phantom, while the solid line represents the mortality curve for mice irradiated without the use of rice bags (irradiated free in air). As can be seen, the addition of a scattering medium significantly influences the lethal doses expressed as r in air. This was to be expected. Withdrawal of the rice phantom shifts the ALD from 1,000 r in air to 1,200 r in air, and the MLD from 200 to 400 r in air. While the LD^{50} with the rice phantom is about 500 r in air, after withdrawal of the rice phantom about 900 r in air are required to produce a mortality rate of 50 per cent within fourteen days.

Discussion

The importance of scattered radiation for depth- and for surface-doses in roentgen therapy is generally recognized. The biologic significance of this physical phenomenon has been extensively studied on the skin and in isolated plant and animal cells (21). A comparative study made by Henshaw and Francis (22), using radiation generated at 200 kv., shows that the percentage of effect produced by irradiation free in air as compared with that on the surface of a paraffin phantom under

the same conditions of irradiation might vary from 10 to 68 per cent for different test objects.

As far as we know, the data presented in this paper are the first to demonstrate the part which back-scatter plays in the irradiation of an entire animal.

The work of Packard (24) with Drosophila eggs and that of Sugiura (26) with tumor fragments have shown a definite parallelism between estimation of the back-scatter by ionization measurements and biologic assay. No attempt has been made to correlate our data with ionization measurements, because no such an agreement between biologic assay and physical measurements as has been found for these comparatively small objects can be expected when a test object the size of a mouse is used.

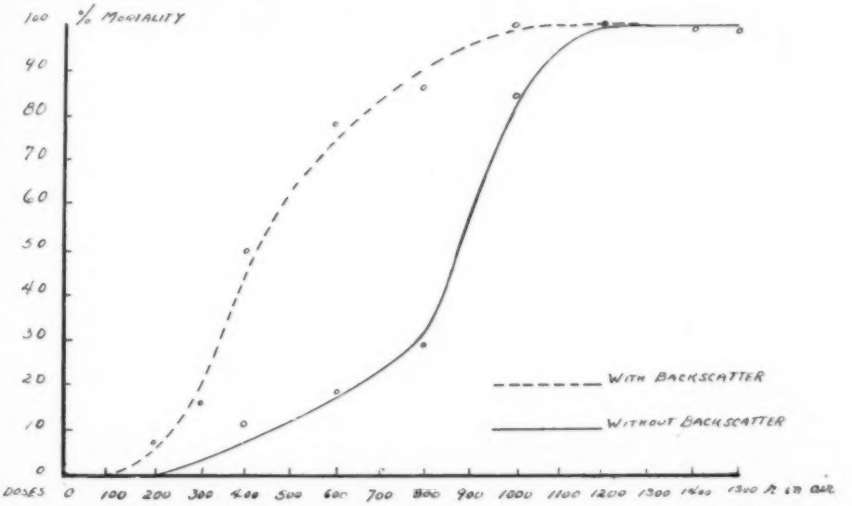


Fig. 14. Mortality curves for mice irradiated on top of rice bags (broken line) and irradiated free in air (solid line). Comparison of these curves clearly demonstrates the influence of the addition of a scattering medium on the lethal effect of x-rays in mice.

The significance of our data seems to be twofold:

(1) They support our previous contention that provision for full use of back-scatter is necessary in the study of radiation effects in total body irradiation of experimental animals.

(2) They give further experimental support to the rule of the Standardization Committee of the Radiological Society of North America (27), which states that to prevent dosimetric errors in radiation therapy due to insufficient depth of underlying tissue, the necessary scattering medium must be artificially provided. The suggestion made by the Committee is that the "total thickness of material (including tissue, the additional material provided, the mattress and wood top of the treatment table immediately underneath) in the x-ray beam beyond the place at which the dose is to be determined should be at least 8 cm."

Rice, which was used in our experiments to build up the necessary depth, is recommended by the Committee for this purpose, because, according to studies carried out by Jacobi and Liechti (23), the back-scatter produced by water and that from rice agree very closely with each other and with the values obtained from animal and human tissues. These results have been confirmed by Quimby and her associates (25).

Since the nature of scattered radiation depends at least in part on the chemical composition of the scattering medium, some of the contradictions in the results of

previous investigators in the field of lethal dose determination in total body irradiation seem to be explained. Obviously these discrepancies will be greater in smaller mammals than in the larger species which, because of their greater mass, provide sufficient or almost sufficient scattering media. In order to obtain conditions of irradiation which are universally applicable in experimental radiation therapy, the inclusion of a well defined scattering medium of sufficient depth in the irradiation set-up appears to be indicated by our experimental data. Rice bags seem to be most convenient for this purpose.

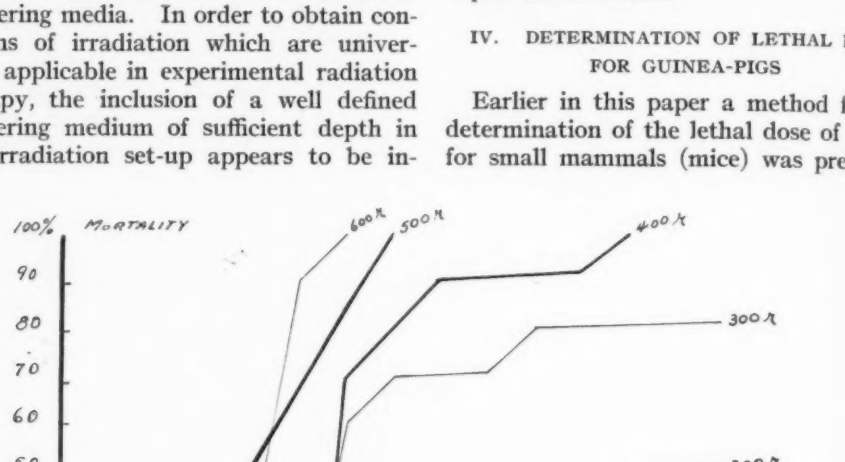


Fig. 15. Lethal dose curves for guinea-pigs. The mortality increased progressively as the doses were raised from 100 to 500 r in air. Increases over 500 r in air did not increase the mortality rate.

Summary

Experimental data showing the influence of back-scatter on the lethal effect of x-rays (HVL 1.25 mm. Cu) in total body irradiation of mice are presented.

The importance of the inclusion of a well defined scattering medium of sufficient depth to provide maximum back-scatter in the irradiation set-up is outlined, and it is explained that only by adopting this procedure can universally comparable data be obtained concerning lethal doses for smaller laboratory animals.

Rice bags, already in use for the purpose of providing additional back-scatter in radiation therapy, are suggested as a suitable means for such a standard set-up in experimental studies.

IV. DETERMINATION OF LETHAL DOSE FOR GUINEA-PIGS

Earlier in this paper a method for the determination of the lethal dose of x-rays for small mammals (mice) was presented (page 126). In a further series of experiments the same method was applied to a larger animal. The guinea-pig was chosen as the largest animal which could be used without a fundamental change in the conditions of irradiation.

Technic: The radiation factors were those previously used (page 126). The doses ranged from 100 to 600 r in air and were given in all instances in one continuous exposure.

A total of 55 guinea-pigs, all males, were used, 6 of which served as unirradiated controls. The weight of the animals varied between 400 and 550 gm. For each ex-

posure 2 animals were placed in linen bags on top of the rice phantom, as described above (page 126).

General Appearance of Irradiated Guinea-Pigs: For six to eight days after exposure (depending on the dose) the appearance of the irradiated animals differed in no way from that of the unirradiated controls. After this latent period some of the animals suddenly exhibited severe dyspnea and died within a few hours. When the first fatalities occurred, the rest of the animals of the same lot usually showed ragged fur, loss of appetite, and diarrhea. Depending on the size of the dose, some recovered and within twenty days their appearance was almost the same as that of the controls.

Postmortem Examinations: The postmortem examinations revealed severe injury to the blood-forming tissues. These changes were most conspicuous in spleen and bone marrow. With increasing doses of x-rays, atrophy and shrinkage of the lymphatic tissues increased. Histologic examination revealed progressive depletion of lymphatic elements in the sternal bone marrow and spleen, in direct proportion to the doses employed. As in mice, the malpighian bodies of the spleen permitted some quantitative evaluation of the radiation effect. In a guinea-pig which died on the twelfth day after exposure to 200 r in air, the malpighian bodies were still present. There was a decrease in lymphocytes, with increase in fibrous tissue and red blood cells. The bone marrow showed considerable depletion of white elements. In surviving animals killed on the sixtieth day after exposure, both bone marrow and spleen were entirely normal in appearance. The spleens of guinea-pigs which died on the twelfth day after exposure to 400 r in air showed only small remnants of lymphatic elements and a very considerable increase in fibrous tissue. Much hemosiderin was found in the spleens of these animals. The bone marrow showed a still greater depletion of white elements. The spleen of an animal which died on the twenty-fourth day after exposure to 400 r in air was hyperemic; the malpighian bodies were indistinctly outlined. The bone marrow was crowded with immature blood cells; the majority were megakaryocytes, but myelocytes were only rarely found. The most pronounced destruction was seen in an animal which died on the eighth day after exposure to 600 r in air. Here practically no malpighian bodies could be discovered in the hyperemic spleen; only here and there some white elements were present. The bone marrow was almost devoid of white cells.

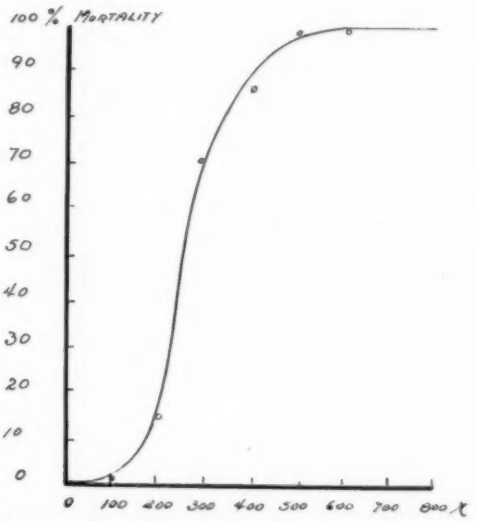


Fig. 16. Mortality curve for guinea-pigs, fourteenth day after exposure to x-rays.

Besides these findings in spleen and bone marrow, there were frequent hemorrhages in the lungs and severe mucosal hemorrhages in stomach and duodenum. Most interesting was the observation of fatty degeneration in the livers of some animals, with definite arrangement of the fat around the central vessels. A detailed discussion of these findings will be given in a later paper.

Relationship between Doses of X-Ray and Mortality: The relationship between doses of x-ray and mortality is presented in the form of lethal dose curves (Fig. 15). As can be seen, with increasing doses, up to 500 r in air, the percentage mortality

increases. Thus, *500 r represents the absolute lethal dose (ALD)* in this instance.

In accordance with the procedure employed in the experiments with mice, the mortality curve for guinea-pigs exposed to x-rays under our standard conditions of irradiation has been constructed. As can be seen from Figure 16, *the relationship between doses of x-rays and the lethal effect in guinea-pigs is expressed by an S-shaped curve.*

Discussion

General Discussion: The data presented above demonstrate that the method of lethal dose determination evolved from studies of small mammals can be applied to larger animals. Our data are in close agreement with the findings of previous investigators, in spite of different methods.

Fabricius-Moeller (30) stated that 7 or more Holzknecht units invariably killed guinea-pigs within thirteen days. This dose corresponds to about 70 per cent of a skin erythema dose, or roughly 420 r in air. Jugenburg (31) irradiated 36 guinea-pigs with half a skin erythema dose, or approximately 300 r in air (factors: 200 kv., 0.5 mm. Zn and 3.0 mm. Al filtration, 40 cm. distance). Of the 36 animals, 33 or about 90 per cent died within twelve to fourteen days. Woenckhaus and Münzel (32) irradiated a small number of guinea-pigs, using 185 kv., 0.5 mm. Cu and 1.5 mm. Al filtration, and a distance of 30 cm. A dose of 145 r in air produced a severe drop in the leukocyte count three hours after exposure, followed by a rise, the so-called *poussée leucocytaire* of Aubertin and Beaujard (28). Beginning with the second day a leukopenia developed, with a final return to normal. No fatalities were recorded. The first fatalities were observed after exposure to 290 r in air, while doses of 435 and 580 r invariably produced death.

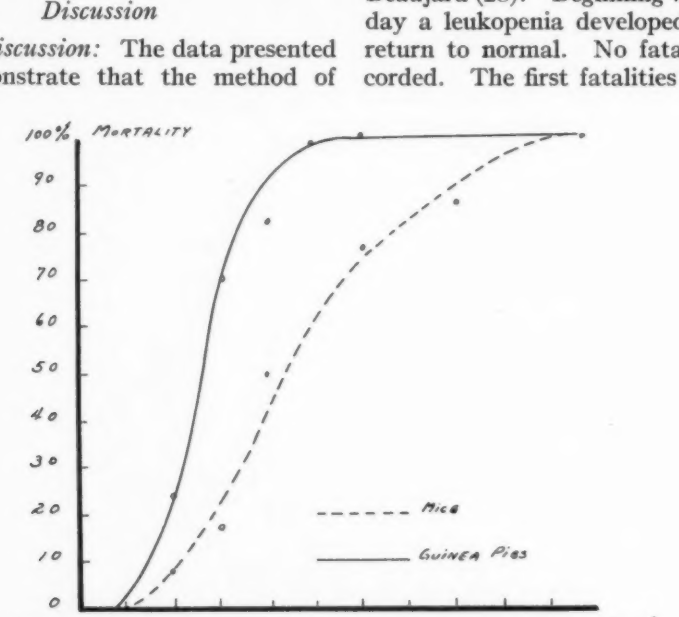


Fig. 17. Mortality curves for mice (broken line) and for guinea-pigs (solid line), fourteenth day after exposure to x-rays. The much steeper slope of the curve for guinea-pigs is of interest as a possible expression of species specificity.

Comparison of Results with Those Obtained in Mice: It is interesting to note that, corresponding to the observations on mice, as the absolute lethal dose for guinea-pigs was approached, increasingly destructive effects in the blood-forming tissues were observed. When the ALD was reached, complete destruction of the malpighian bodies of the spleen was noted.

It is of interest, also, that in guinea-pigs the latent period between exposure and occurrence of the first fatalities was nearly

twice as long as in mice. Depending on the dose of x-rays used, the latent period in guinea-pigs varied between six and eight days, the corresponding period for mice ranging from two to six days. Even with administration of about three times the ALD, this prolonged latent period was observed in guinea-pigs. According to Clarkson, Mayneord, and Parsons (29), all of 6 guinea-pigs exposed to 1,500 r in air (factors: 150 kv., 4 ma., 0.3 mm. Cu inherent filtration) died on the fifth day after exposure.

The much steeper slope of the mortality curve of guinea-pigs seems to merit attention. Figure 17 clearly demonstrates this difference in the two species.

Both observations, the prolonged latent period and the steeper slope of the mortality curve of guinea-pigs, may be considered as an expression of species specificity. It is also of interest to note that the life span of the guinea-pig is approximately double that of the mouse.

Summary

The applicability of a method for the determination of lethal doses of x-rays derived from the study of mice has been demonstrated for a larger animal, the guinea-pig.

With increasing doses of x-rays, an increase in the percentage mortality was found up to 500 r in air. This dose represents the absolute lethal dose (ALD) for guinea-pigs under our conditions of exposure.

As in mice and goldfish, the relationship between dose of x-rays and percentage mortality is expressed by an S-shaped curve.

Comparison of the mortality curves of mice and guinea-pigs shows a steeper slope of the curve for guinea-pigs. In connection with some observations concerning the latent period, this is considered to be an expression of species specificity.

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Foreign Bodies in the Digestive Tract[1]

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FOREIGN BODIES in the digestive tract are a not infrequent finding. Usually they give no trouble, simply making their way out through the natural passages. It is indeed surprising that objects of considerable size and unusual shape, including open safety pins, manage to pass through the esophagus, stomach, and bowels without producing any injury to these structures. An interesting example is the case of a man who swallowed a complete upper denture. The object was followed fluoroscopically as it passed through the entire alimentary tract until it was recovered and was eventually restored to its natural habitat, the mouth. The patient was none the worse for his unusual experience.

Foreign bodies in the digestive tract may be classified in four groups depending upon the degree of resistance to x-ray penetration.

(1) Opaque foreign bodies, usually metallic, are the most resistant and are readily recognized in the roentgenogram.

(2) Semi-opaque foreign bodies, including bone fragments and any substance containing calcium, offer only partial resistance. Their demonstration depends upon their size and location.

(3) Non-opaque foreign bodies, possessing the same resistance as the surrounding tissue, can be recognized only by indirect measures, as the introduction of an opaque fluid substance.

(4) Translucent foreign bodies of low density, such as fat masses, exhibiting less resistance than the adjacent tissues, are recognized by the so-called negative shadow.

In general it may be said that any foreign body that becomes lodged anywhere in the alimentary tract is a source of serious danger because of possible obstruction, perforation, or abscess formation. It is, therefore, quite apparent that a diagnosis must be established as soon as possible in order to enable the surgeon to remove the foreign body before complications set in.

Several cases have been selected to illustrate the four groups of foreign bodies and the particular technic applied in their demonstration. Since the site of lodgment determines the type of technic to be used, the discussion will follow anatomical lines.

THE CERVICAL ESOPHAGUS

The cervical portion of the esophagus is the most frequent site for the lodgment of foreign bodies. This is to the advantage of both roentgenologist and laryngologist, because of the relative ease in making an accurate diagnosis and the accessibility of the foreign body for removal.

A lateral view of the neck is obtained at 6 feet distance, with the cassette placed against the shoulder. Such a roentgenogram will show all the cervical vertebrae and soft structures of the neck.

A study of the lateral roentgenogram of the neck will reveal three parallel columns of varying degrees of density. The posterior column, the densest, is formed by the bodies of the cervical vertebrae. The anterior column is translucent and represents the air-containing trachea. The middle column is semi-opaque and is the narrowest one of the three, representing the cervical portion of the esophagus (Fig. 1). Except in infants this relationship appears to be constant regardless of sex, height, weight or habitus. Whenever the diameter of the middle column exceeds that of either of the other two, the possibility of a foreign body should be considered, especially in the presence of a suggestive history. This widening of the retrotracheal space may be due to the bulk of the foreign body, to swell-

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

Fig. 1. Lateral roentgenogram of the neck, showing three parallel columns. Except in infants, the middle or retrotracheal column, containing the cervical portion of the esophagus, is normally the narrowest of the three.

ing of the esophageal mucosa, or to a formed abscess.

The presence of a foreign body without widening of the retrotracheal space (Fig. 2) indicates that the accident is of recent occurrence, since not enough time has elapsed to produce a reaction in the tissue, with characteristic swelling of the mucosa. On the other hand, if the space is widened and it is known that the accident was of recent occurrence, the probability is strong that the widening is due to the bulk of the foreign body. An illustrative case is that of a man who was examined only two hours after the accident (Fig. 3, A). A minute fragment of bone was observed, which was obviously not responsible for the widening. Upon ingestion of a single mouthful of a barium mixture, the enlarged retrotracheal space was found to be mottled, the mottling apparently representing the outline of a soft-tissue mass comprising the bulk of the foreign body (Fig. 3, B). This interpretation was confirmed by the removal of fragments of meat.

In the presence of a foreign-body shadow in the esophagus, the introduction of an opaque mixture appears to be an unnecessary procedure. Its use should be reserved for doubtful cases or cases where no opaque body is demonstrable. It must be absolutely avoided if the foreign body is in the stomach or intestines, for it may then obscure the mass.

Fig. 2. Fragment of bone at the root of the neck. The middle column is not widened, indicating absence of complications.

When the widening of the retrotracheal space is due to swelling of the mucosa, the case is usually of several days' duration. Figure 4 illustrates a case in which the patient failed to consult a physician for several days after the accident. A lateral teleroentgenogram of the neck showed widening of the retrotracheal space and, within the swelling, an indistinct linear shadow of only slight opacity. Notwithstanding the positive diagnosis of a foreign body, the surgeon could not locate it. Only

Fig. 3. A. Roentgenogram made two hours after the swallowing of a foreign body. The middle column is widened, containing a minute fragment of bone. B. Roentgenogram of same patient, made after ingestion of barium. The mottled appearance is due to fragments of meat.

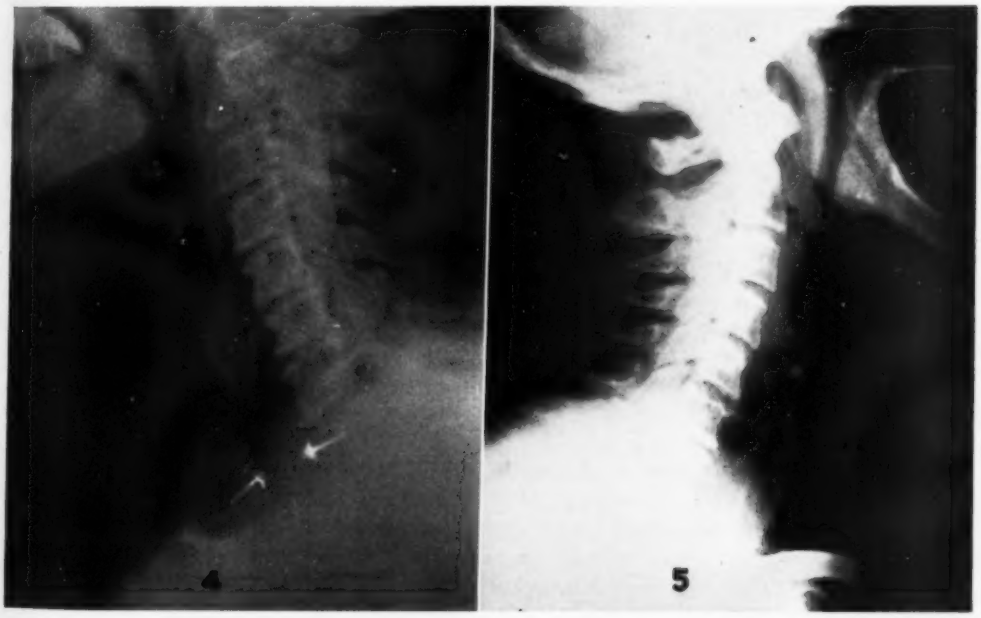

Fig. 4. Widening of retrotracheal space due to swelling of mucosa, with an indistinct shadow of a bone fragment swallowed several days earlier.

Fig. 5. Widening of retrotracheal space, with a fish-hook-like shadow due to a fragment of bone. The foreign body was obscured by the swollen mucosa.

Fig. 6. Large swelling of retropharyngeal and tracheal space due to an abscess. Note the shadow of a bone fragment and gas bubble indicative of perforation.

upon a second trial several days later was it located and removed. The first failure was obviously due to the greatly swollen mucosal folds that hid the object from view.

The serious consequences of delay in consulting a physician are illustrated by the case of a man who swallowed a chicken bone which apparently became lodged at the root of the neck. The physician was not called until symptoms of suffocation developed, about four days after the accident. The patient was immediately transferred to the hospital and a tracheotomy was performed. On the following day an x-ray examination of the neck revealed widening of the retrotracheal space with a fish-hook-like shadow of moderate density in the widened area. There were also several irregular translucent areas, but whether these were air bubbles resulting from perforation or from the tracheotomy was difficult to determine (Fig. 5). Attempts to remove the bone fragment were made, but it could not be located. The condition became complicated by abscess formation requiring an operation. The patient finally succumbed, and at necropsy the bone fragment was found deeply embedded in the swollen mucosal folds.

The following case illustrates the serious results which may occur when a general practitioner assumes the responsibility of determining the presence or absence of a foreign body. A patient, soon after having swallowed a piece of bone, consulted a physician, who made a fluoroscopic examination of her neck and assured her that there was no sign of a foreign body. (Parenthetically it may be said that roentgenologists who are skillful with the use of the fluoroscope do not have the temerity to draw positive conclusions as to the absence of a foreign body without the aid of roentgenograms.) After several days the patient's condition grew worse and she was then referred to an otolaryngologist. A roentgenogram of the neck revealed marked increase in the width of the retropharyngeal and tracheal spaces. Within the swelling a fragment of bone and a bubble of gas (a pathognomonic sign of perforation) were observed (Fig. 6). The diagnosis of an abscess was quite evident, but attempts at operation failed to save the life of the patient.

In examining the neck for possible foreign bodies, one should also pay attention to translucent shadows. Figure 7, A, is a roentgenogram showing widening of the retrotracheal space, within which is an indistinct shadow of a fragment of bone and above this a translucent area. In order to differentiate between a bubble of gas in the esophagus and a piece of tissue of low density, a teaspoonful of lipiodol was given. Instead of displacing the translucent shadow, as would happen if it were free air, the lipiodol appeared to encircle it (Fig. 7, B), proving it to be tissue of low density, namely fat. This was confirmed by the removal of the foreign body.

THE ESOPHAGUS WITHIN THE THORACIC CAGE

Only foreign bodies of dense consistency can be directly demonstrated in the esopha-

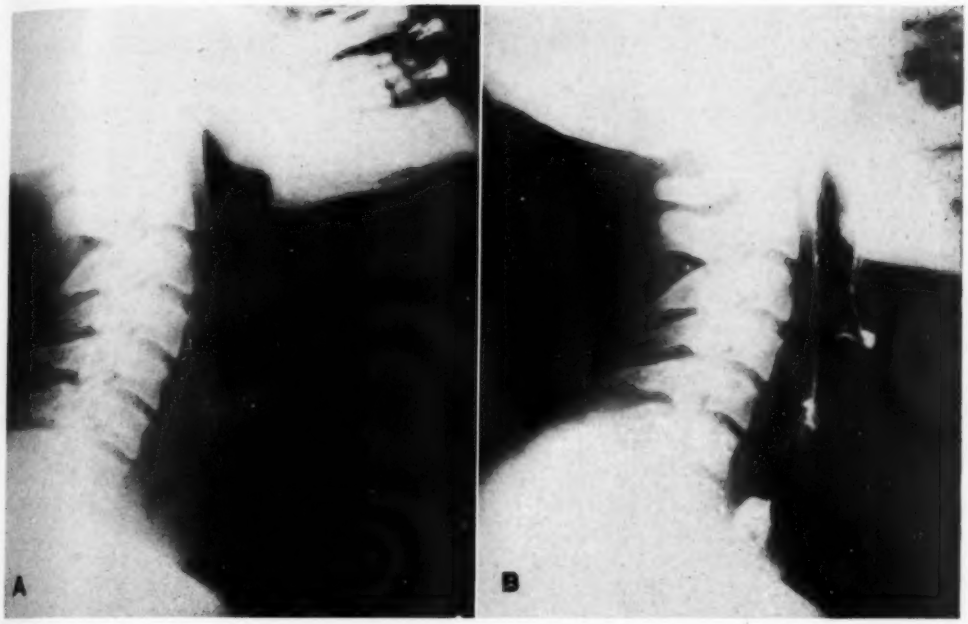

Fig. 7. A. Retrotracheal swelling with translucent shadow and indistinct fragment of bone. B. Roentgenogram made after ingestion of lipiodol. The translucent shadow remains, indicating that it is due to fat and not to a bubble of gas.

Fig. 8. Dense shadow due to a fragment of bone in the esophagus, present for several months.

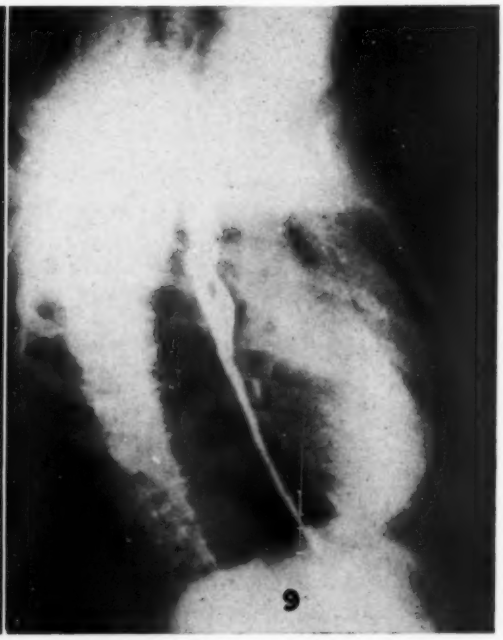

Fig. 9. Bifurcation of barium column, due to a fragment of bone below the aortic arch.

Fig. 10. Abrupt stoppage of the barium column about two inches above the cardiac end of the esophagus, due to a plug of meat.

Fig. 11. Hairpin at the pyloric end of the stomach, penetrating its wall. The open ends are embedded in the head of the pancreas.

gus within the thoracic cage, and then only in the lateral projection. Semi-opaque or non-opaque foreign bodies can be diagnosed only after the ingestion of an opaque mixture.

The following case, illustrating a dense foreign body in the esophagus, is interesting from several angles. While partaking of a chicken dinner, the patient experienced a painful sensation deep in the chest. He immediately consulted a physician, who appears to have disregarded the history, treating the patient for several months for digestive disturbances. Having failed to respond to the treatment, the patient was advised to consult a gastro-enterologist. He carried out the usual procedures in the examination of the gastro-intestinal tract, including a complete x-ray examination by a competent roentgenologist, who concluded that a duodenal ulcer was present. The patient was treated accordingly, but failed to respond. After several weeks, he was referred to an otolaryngologist for examination of the esophagus, evidently as a result of greater attention to the clinical history. Upon fluoroscopic and roentgenographic examination at this time a dense shadow was observed in the region of the esophagus just above the diaphragm (Fig. 8). The patient made a rapid recovery after removal of a fragment of bone.

A second case is that of a woman who presented the usual history of deep-seated pain in the chest after swallowing a chicken bone. A plain view of the thoracic cage failed to reveal positive signs of a foreign body. After ingestion of a small amount of barium mixture, a bifurcation of the current just below the aortic arch was observed (Fig. 9). The diagnosis of a non-opaque foreign body was confirmed by the removal of a tiny piece of chicken bone.

A frequent cause of obstruction of the lower end of the esophagus is fragments of meat. During the course of a beefsteak

Fig. 12. Feeding tube remaining in the stomach for a week.

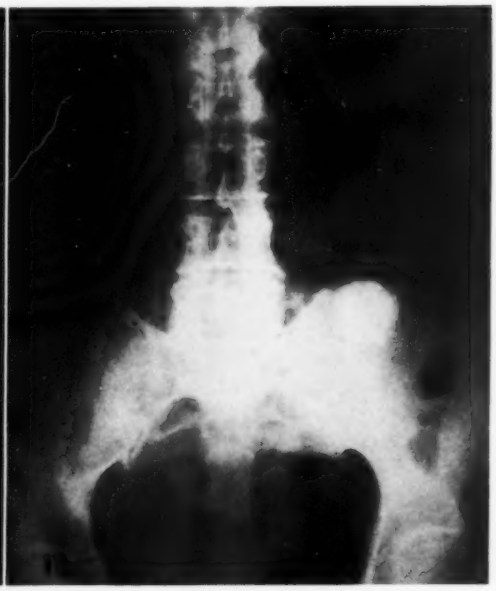

Fig. 13. Gallstone in the small bowel, producing intestinal obstruction.

dinner a patient suddenly felt a pressure sensation deep in the lower region of the chest. He was unable to continue his dinner because of regurgitation of food. A physician was immediately called, but x-ray examination of the chest revealed no unusual shadows. After the ingestion of a barium mixture, an abrupt obstruction was noted about 2 inches above the diaphragm, indicating the presence of a foreign body (Fig. 10). This was removed and was found to consist of a good-sized mass of meat. In general, ordinary food does not seem to fall under the heading of foreign bodies, but when stalled in the passageway, it must be regarded as such and is, relatively speaking, of frequent occurrence.

THE STOMACH

Many foreign bodies have been found in the stomach, especially of metallic nature. Their diagnosis is quite simple. The following case is of special interest and merits a more detailed report. The first examination was made by Dr. Nathan Flax because of gastro-intestinal disturbances. X-ray examination of the stomach revealed a hairpin in the pylorus with the open ends protruding through its wall (Fig. 11). The patient was taken immediately to the hospital and a second x-ray examination confirmed the previous findings. Operation disclosed a rusty hairpin, which had penetrated the pyloric end of the stomach, with the open ends embedded in the head of the pancreas. There was no sign of abscess formation, and the patient made an uneventful recovery. During the interrogation he denied any knowledge of ever swallowing a hairpin. He did admit, however, that, many years before, he had been in the practice of hairdressing.

The use of gastric tubes for various purposes is a common practice, and so long as the outer end is anchored, the tube is not regarded as a foreign body. If, however, it becomes disengaged from its anchor and slips down into the stomach, it immediately comes under that category. Such an instance occurred recently in our hospital. The patient, aged 75, with an extensive carcinoma of the mouth was fed through a gastric tube introduced through the nasal passage. It was anchored to the nose but

unfortunately became loose and was swallowed (Fig. 12). Several attempts were made to remove the tube from the stomach by gastroscopy, but all were unsuccessful. The tube remained in the stomach for a week with no tendency to enter the bowels. More radical measures for its removal were considered, but before they were carried out the patient died of carcinoma.

THE INTESTINES

Gallstones are not foreign bodies so long as they remain in the gallbladder, but when they become lodged in the intestines, their action is similar to that of any other foreign mass and serious consequences to the patient may ensue. The following case is one of several coming under observation. The patient was admitted to the hospital because of symptoms of acute obstruction. A plain view of the abdomen revealed moderate gaseous distention of the small bowel, with a dense circular shadow overlapping the left ilium (Fig. 13). The laminated character of the shadow was strongly suggestive of a gallstone. Immediate operation, revealing an obstructing gallstone in the small bowel, confirmed the diagnosis. In not all the cases are the stones so dense as in the present instance, but a careful study of the film in cases of intestinal obstruction may reveal suggestive shadows.

SUMMARY AND CONCLUSION

Foreign bodies of whatever nature may prove to be of serious significance when they are stalled anywhere in the course of the digestive tract. The diagnosis must be made with the least possible delay, in order to prevent such complications as obstruction, perforation, and abscess formation. Roentgen examination has been found to be the most useful method for establishing an accurate diagnosis.

The technic is simple. A fluoroscopic survey should be made of the neck, chest, and abdomen, especially in the case of infants and children. In adults, a lateral view of the neck in the presence of a foreign body will reveal direct or indirect evidence in practically all cases. One should carefully note the width of the retrotracheal space, which is, as a rule, normally narrower than that of the trachea or the bodies of the vertebrae. If the width of the retrotracheal space exceeds that of the trachea or the vertebral bodies, one should suspect the presence of a foreign body even in the absence of shadows of bone fragments.

Most of the foreign bodies in the thoracic portion of the esophagus can be demonstrated indirectly by the introduction of an opaque substance, but first a plain lateral view of the chest should be made and carefully examined in order to avoid obscuring a moderately dense shadow of a foreign body.

Several cases have been selected from a large group, illustrating various foreign bodies in the digestive tract.

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Atypical Pneumonia with Roentgen and Pathologic Findings[1]

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ATYPICAL pneumonia has been reported as occurring in various Army and Navy organizations, as well as in civilian institutions in the United States, during the last few years. It is probably an old disease, endemic in some localities, assuming epidemic character due either to change in the virulence of the causative agent or an increase in individual susceptibility. The diagnosis is made from the history, physical examination, evaluation of laboratory findings, as smears from sputum or throat washings, animal inoculations and blood cultures, and roentgen examination. The clinical course of atypical pneumonia, possibly of virus origin (1–3), differs somewhat from that of bacterial pneumonias, in that the patient with atypical, non-bacterial pneumonia is not so ill.

No one to date has been able to isolate a causative agent of atypical pneumonia of non-bacterial origin to be found in the majority of cases. It is believed by some workers, however, that parrot fever, ornithosis, or psittacosis is related closely to the disease, if not the direct cause in some instances (4). It seems unlikely that the psittacine virus could be the direct cause of all atypical, non-bacterial pneumonias, as usually the patients with psittacosis are decidedly more ill than the average patient with atypical pneumonia of non-bacterial origin.

The onset in the non-bacterial type of pneumonia is often insidious, with mild coryza and a watery nasal secretion which soon becomes tenacious and at times blood-streaked but not grossly bloody. There is an annoying cough, possibly with substernal pain and malaise, but seldom are there enlarged cervical nodes. The temperature is usually elevated; it may reach 102 or 103° F. but rarely 104° or 105° F. In our series of 91 cases there were 2 with a temperature of 106° F. and 6 reaching 105° F. The temperature dropped by lysis, as a rule, in five to twenty days after the onset of the disease. In this series the majority of patients were fever-free ten days after entering the hospital. Seldom did the temperature fall below 98°. It has been observed by some that in atypical, non-bacterial pneumonia the temperature often drops about the third day. This finding was not particularly in evidence in our series except where it was believed to be due to the effect of one of the sulfa drugs, administered during the preceding twenty-four or forty-eight hours, on secondary bacterial invaders. There was slight, if any, elevation of the pulse or respiratory rate. Rarely did the pulse rate exceed 100. In the majority of cases it was seldom over 80 per minute; in a few it ranged from 80 to 90 per minute. If considerable consolidation developed, the pulse was likely to be rapid. The average respiratory rate was 20 per minute. In a moderate number of patients the rate was from 20 to 30 per minute. In few was it as high as 40 per minute. The following symptoms were frequently present but varied considerably in degree and often were absent: chills, headache, muscle soreness, sweating, expectoration, sore throat, and chest pain.

The average blood counts were as follows for the 91 cases:

	Low	High	Average
Red cells	3,360,000	5,780,000	4,880,000
Hemoglobin	70%	120%	87%
White cells	3,900	23,000	5,500
Neutrophils	50%	90%	72.5%
Lymphocytes	5%	44%	10.9%
Eosinophils	0%	10%	1.6%
Non-segmented cells	6%	56%	24.9%
Large monocytes	0%	25.5%	4.6%

The x-ray findings as observed in our series followed a pattern but were not so constant as to be called characteristic.

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2 1943.

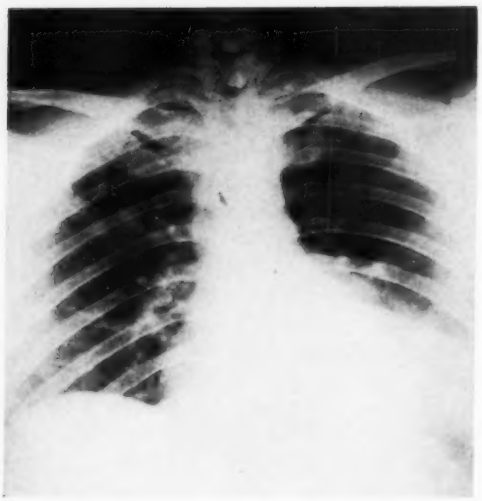

Fig. 1. Roentgenogram showing extremely light pseudopneumonic consolidation in lower lobe of left lung and general increased density of each hilum. This case is one of the three for which autopsy findings are reported.

They could indeed be simulated by various other lung diseases. As a rule, early in the course of atypical pneumonia of non-bacterial origin, a coryza and tracheobronchitis developed, with enlarged hilar shadows of light density. The linear markings about one or both hila increased in size. Small areas of light pneumonic or pseudopneumonic density and atelectasis appeared in one or possibly both lungs. The ensuing pneumonic consolidation and atelectasis usually were lobular rather than lobar in character and were most often in but one base rather than bilateral. Local areas of emphysema developed and seldom was there an associated elevation of either hemidiaphragm. This picture differs somewhat from that of total atelectasis with no local associated emphysema at the bases of the lungs seen in bacterial pneumonias. Resolution took place irregularly, starting at the periphery of the lung and advancing into the hilum. This mode of clearing is the direct opposite of that observed in the bacterial pneumonias. The clearing process was not uniform, however, and was frequently erratic. One area of lung was often clearing while another was consolidating. There were often residual thickening of linear markings, interstitial pneumonitis, and at times small transverse linear areas of atelectasis in regions formerly consolidated, remaining only a few days or, in some cases, several weeks after the patient was otherwise apparently well. The frequency of consolidation occurring in various lobes was as follows: right lower lobe, 29 times; left lower lobe, 23 times; left upper lobe, 10 times; right middle lobe, 8 times; right upper lobe, 7 times; right hilum, 24 times; left hilum, 19 times.

The x-ray picture in general revealed more disease than the physical findings would lead one to believe possible. One could often diagnose a pneumonic process largely by x-ray before the physical findings were sufficiently pronounced to indicate the type of disease present. The diagnosis was made largely by the process of exclusion of other known causes of pneumonia and other lung diseases, and by evaluation of the history and physical findings, laboratory studies, and roentgen examination.

It is known that non-virus pneumonias may be caused by the staphylococcus, streptococcus, influenza bacillus, Friedländer's bacillus, *B. tularensis*, rickettsial agents, and toxoplasma. It is not unusual to find two or more organisms causing a pneumonia and thereby complicating the clinical, laboratory, and x-ray findings, as well as the therapy. A variety of organisms were identified from the sputum in our series of atypical pneumonias, either by direct smears or injections into ferrets and mice. By these methods one obtains valuable information helpful both in diagnosis and treatment. Our findings were as follows:

Streptococcus viridans in 11 patients.
Staphylococcus aureus in 11 patients.
Micrococcus catarrhalis in 9 patients.
Streptococcus haemolyticus in 7 patients.
Haemophilus haemolyticus in 4 patients.
Non-hemolytic streptococcus in 4 patients.
Haemophilus influenzae in 2 patients.
Pneumococcus Type XIII in 1 patient (mouse injection).

Pneumococcus Type II in 2 patients (Neufeld reaction).
Pneumococcus Type X in 1 patient (peritoneal exudate from injected mouse).
Pneumococcus Type III in 1 patient (quellung reaction).
Lancet-shaped diplococci in 1 patient (quellung reaction).
Gram-positive cocci
Singly in 2 patients.
In pairs in 2 patients.
In long chains in 1 patient.
In short chains in 2 patients.
Gram-positive bacilli in 1 patient.
Gram-negative bacilli in no patient.

There were no positive blood cultures in this series.

Emphasis should be placed on the importance of an early blood culture, as well as a bacterial analysis of sputum or throat washings, before administration of drug therapy, as bacterial growth, as well as the clinical picture, may be altered by chemotherapy. One should not delay, however, in prescribing the sulfa drugs even before the results of the laboratory tests have been ascertained, thereby avoiding the loss of valuable time in the treatment of the patient. As it is claimed that 86 per cent of all pneumonias are caused by bacteria, four-fifths of which are the pneumococcus types I to VIII, inclusive, it is reasonable to assume that a high percentage of cases treated by sulfa drugs will be benefited, regardless of whether the pneumococcus is present as the direct cause of the pneumonia or as a secondary invader. In our atypical pneumonia series one could usually determine if secondary invaders had entered the picture by the accentuation of the symptoms or the finding of the organism in the patient's sputum or blood.

It is not often possible to find a causative agent from secretions, blood, or sputum, although some virus infections can be reproduced in ferrets and may then be transplanted into mice. The viruses of influenza A and B and also psittacine virus have at times been found in cases of atypical pneumonia.

The influenza virus is virulent in ferrets, which produce antibodies. The disease can thus be definitely identified. Pneumonias, at times fatal, are said to be produced by the Rickettsias of typhus fever, Rocky Mountain fever, and Q fever. A very severe and contagious pneumonia occurs from infection with the psittacosis virus. This virus can be recovered from the infected patient's sputum, and a complement-fixation test is specific for the disease. Tularemia may produce pneumonia, *B. tularensis* entering the body during the handling of wild rabbits or other animals. The organism may even enter the lungs by inhalation during the shearing of sheep. The infection causes enlargement of the lymph nodes of the body. The axillary nodes are prone to enlarge when infection occurs through an abrasion of the hand. These nodes are firm and do not respond well to x-ray or other therapy.

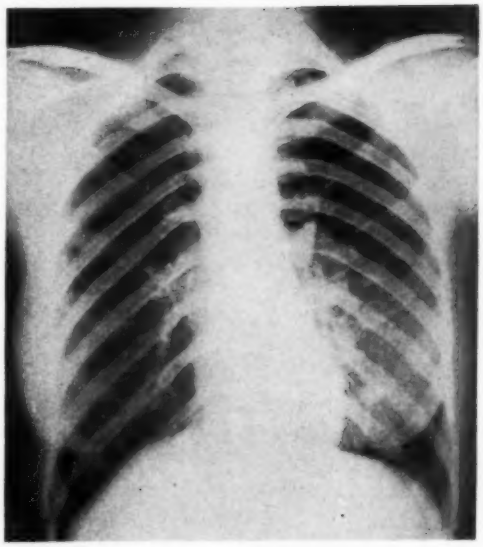

Fig. 2. Light-density pseudoconsolidation seen in the average case of atypical, non-bacterial pneumonia.

Clinically the Friedländer bacillus produces a much more severe pneumonia than the atypical, non-bacterial (virus) type, with chills, fever, rapid respiration, high pulse rate, pain in the chest, often cyanosis, and red non-viscid sputum. No leukocytosis is present, as in pneumococcus pneumonia. The disease terminates fatally.

Pneumococcus pneumonia differs from the non-bacterial type (virus) in being very severe, with chills, high fever, and rusty sputum, which is viscid. Both pulse and respiration are rapid. The area of lung involvement as observed by x-ray in pneumococcal lobar pneumonia is dense as compared with the lobular areas of light density seen in non-bacterial (virus) pneumonia. The leukocytosis is often very high in contradistinction to the comparatively slight leukocytosis of (virus) nonbacterial pneumonia.

The sulfa preparations, penicillin, and other forms of drug therapy have not been beneficial in treating uncomplicated nonbacterial (virus), atypical pneumonia. These cases are best treated symptomatically. Death seldom occurs from the uncomplicated disease. The sulfa drugs and penicillin are useful only for combating secondary bacterial invaders.

PATHOLOGICAL FINDINGS

Like others interested in primary atypical pneumonia, we have had only a limited opportunity for anatomical study of the disease, on account of the low mortality rate. In the late months of 1942, 3 cases which terminated fatally came under our observation. The clinical manifestations in these were so similar to those in numerous cases with recovery that a brief account of the pathological findings appears warranted.

The patients were young adults, aged 23, 30, and 36 years. Two were males. In none was there a history of recent serious illness. The main clinical features were moderate fever, dry and almost uncontrollable cough, and scanty sputum. The leukocyte count was not elevated. Repeated bacteriological examinations did not disclose the incitants of pneumonic disease. Dyspnea and cyanosis appeared in the last days of life. In each instance the duration of the disease was around three weeks.

Although it is quite probable that the anatomical changes found were more extensive and severe than those in non-fatal cases, the restriction of the lesions to the bronchi and bronchioles, without the development of bronchopneumonia of any important extent, was truly remarkable. The findings in the three cases were so similar that they are most easily described in summary fashion.

The lungs were voluminous and of about twice normal weight. The pleurae were smooth and not involved. Although the lungs were firm, they contained no sizable areas of consolidation and were even emphysematous in portions. The main bronchi contained mucopurulent sputum. Gross sections showed small opaque areas, mainly of circular shape, about the large bronchial radicles. Palpable consolidation was confined to the central parts of the lungs. In the peripheral portions the cut surfaces presented a finely mottled appearance with reddish-gray spots 3 to 4 mm. in diameter, with lighter colored and air-containing areas between them. Small bronchial branches were recognizable in the darker areas and these contained fine droplets of thick, mucoid material. Interstitial hemorrhage was not a feature. Thrombi were found in medium-sized branches of the pulmonary arteries—in some 3 mm. or more in diameter. In smaller branches they were visible only after fixation and were much more evident in microscopic preparations. The thromboses were not accompanied by infarct formation. The areas supplied by the thrombosed vessels were pale red and slightly edematous.

Histologically, the lesions were most severe in the central portions of the lungs and especially about the larger bronchi. In some of the larger branches the walls were partially necrotic and the lumina contained epithelial debris and purulent exudate. Radicles of about equal size showed partial necrosis of the walls with detached and folded epithelium in the lumina but without purulent reaction. In the purulent exudate, small clumps of gram-positive cocci were readily demonstrable.

The lesions in the finer bronchial radicles were much simpler and less complicated by necrosis, reaction to cell debris, and by

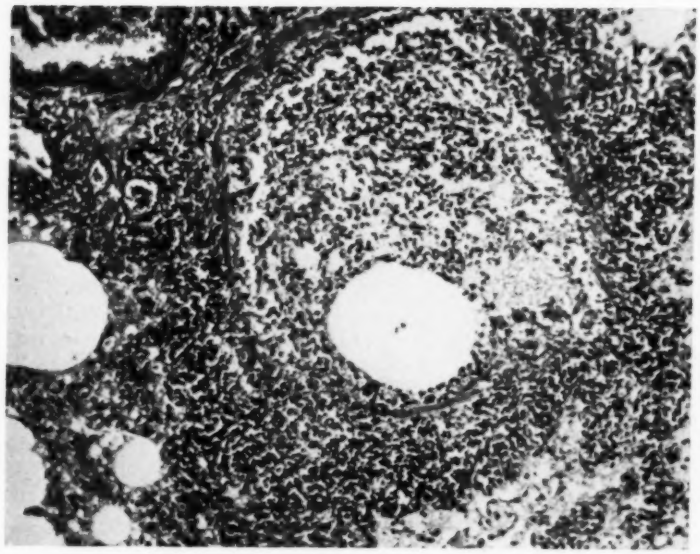

Fig. 3. Section through a small bronchial radicle. The mucosa is entirely destroyed. Remnants of the muscle coat remain. There is compact infiltration of the outer coats by mononuclear cells.

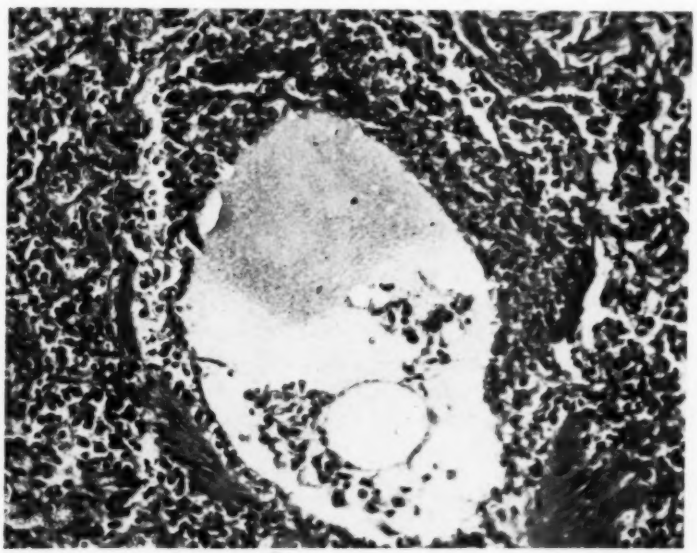

Fig. 4. Section through a bronchiole. The mucosa is completely destroyed. The lumen contains mucoserous fluid. Note the mononuclear character of the cells in the lumen.

secondary invasion by mouth organisms. In these the lumina were filled with mononuclear cells and seromucinous fluid, with or without detached bronchial epithelium. The walls were uniformly infiltrated with mononuclear cells, and purulent reaction was entirely wanting. The detachment of bronchial mucosa appeared to be due to displacement by mononuclear cell infiltration and seromucinous fluid. Other and closely located bronchial radicles were filled with shreds of bronchial epithelial cells, air droplets, and serous fluid.

The thromboses in the pulmonary artery radicles appeared to be important and it is believed that they may have bearing on some of the transitory shadows seen in roentgen films.

SUMMARY

1. In a series of 91 cases of atypical pneumonia of non-bacterial origin, the average age of the patient was 20.9 years. Males and females were affected in approximately equal numbers. All but 2 of the patients were white.

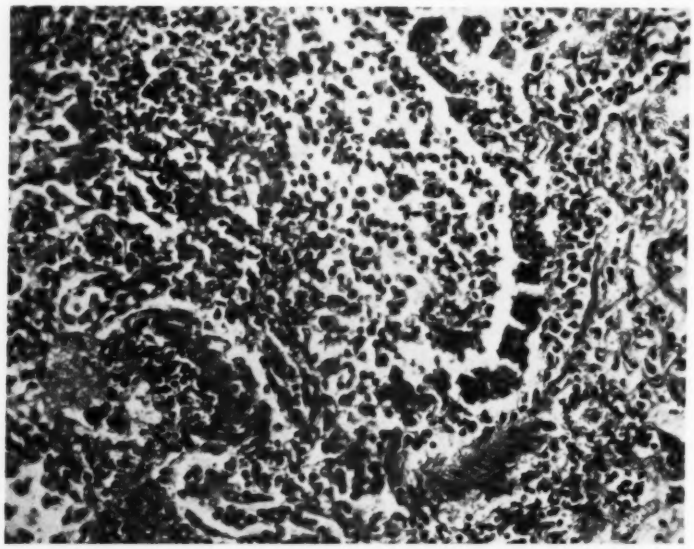

Fig. 5. Section through a small bronchiole. Detached epithelium and mononuclear cells fill the lumen.

The thrombi in the pulmonary artery radicles were compact, formed of fibrinoid material, platelets, and scanty leukocytes. They were loosely attached to the intima of the vessels and there was no inflammatory reaction in the vascular walls. Bacteria were not found in the thrombi.

The bronchiolar lesions were widely disseminated throughout all lobes. Microorganisms were not found in them and they had the characters of non-bacterial lesions. Intracellular inclusion bodies were not demonstrable. Significant changes were not found in other organs.

2. No definite cause of the disease was established, although it is thought to be caused by a virus of undetermined type, or possibly to be due to embolism of the small pulmonary arteries and veins, which would account for its peculiar distribution and transient nature, as suggested by the autopsy findings in 3 cases.

3. The diagnosis is established principally by exclusion of other known diseases, particularly bacterial pneumonias. The following were of value in arriving at a diagnosis: history, physical and laboratory findings, sputum and blood exam-

inations, including blood cultures, and x-ray studies. The clinical course, physical findings, and x-ray changes are in general milder than in bacterial pneumonias. The x-ray changes, though of a pattern, may be simulated by many other diseases and therefore are not characteristic.

4. No specific therapy is known. Symptomatic treatment is successful. Sulfa and other drug therapy is directed toward secondary invaders.

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Anatomical X-Ray Studies of the Lung, Primarily for Tuberculosis[1]

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THE IMPORTANCE of roentgenology in the diagnosis of pulmonary tuberculosis has been gradually and surely established. The clinical symptoms and the infectious nature of the disease had been recorded in the literature by such men as Hippocrates, Laennec, Villemin, and others before Koch's discovery of the tubercle bacillus. By use of the x-ray, it is possible for the pathologist to write a more complete protocol of the lung findings, and it is the pathologist who frequently establishes the primary and contributing causes of death.

Ghon employed x-rays in his anatomical examinations of lung specimens only in exceptional cases in which most careful anatomic search failed to reveal minute calcific tubercles. Opie has made an extensive use of the roentgenographic method in his anatomical studies of pulmonary tuberculosis. Dr. Kornel L. Terplan, Director of Pathology at the Buffalo General Hospital, asked the co-operation of the X-Ray Department in the anatomical study of lung specimens The purpose of such examination is to locate more easily and accurately very small chalky and calcified lesions. Histologic examination of all lesions was found to be indispensable.

Over a period of ten years we have examined by x-ray 800 lung specimens. Doctor Terplan has selected the cases shown in the accompanying plates and prepared the brief summary attached to each illustration.

The technic used in producing these roentgenograms was as follows: The specimen was placed on the x-ray table top, protected by black photographic paper. The film, in a cardboard holder, was placed in the drawer of the Potter-Bucky diaphragm. The target-film distance was 28 inches. Other factors were: 75 kv., 35 ma., exposure time 3 1/2 seconds. The factors were adjusted to the size of the specimen.

The above factors gave satisfactory roentgenograms of the lung specimens, as the accompanying plates demonstrate. The specimens were not inflated with air nor were any other procedures used.

Before arriving at this method, many others were tried. The plain film and the Bucky diaphragm seem to be the principal factors.

The final pathological observations based on the large group of specimens studied will be published later by Doctor Terplan. The purpose of this paper is simply to present a method that produced satisfactory roentgenograms of lung specimens.

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

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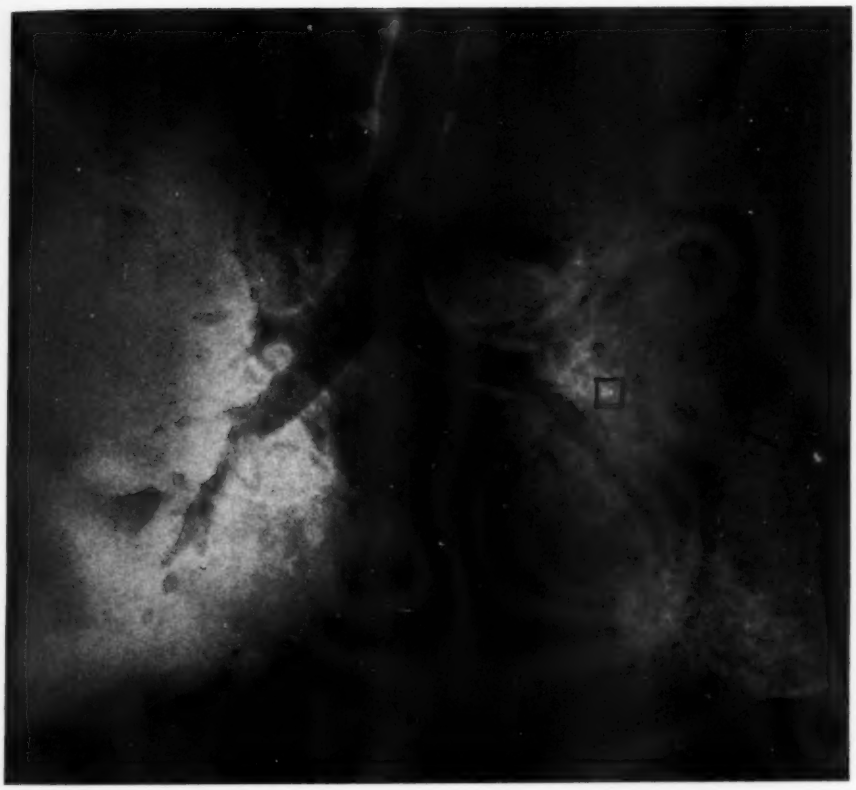
Buffalo 3, N. Y.

PLATE I



Specimen from a white adult. Cause of death: automobile injury with concussion of the brain. Diffuse aspiration pneumonia, especially of the right lung.

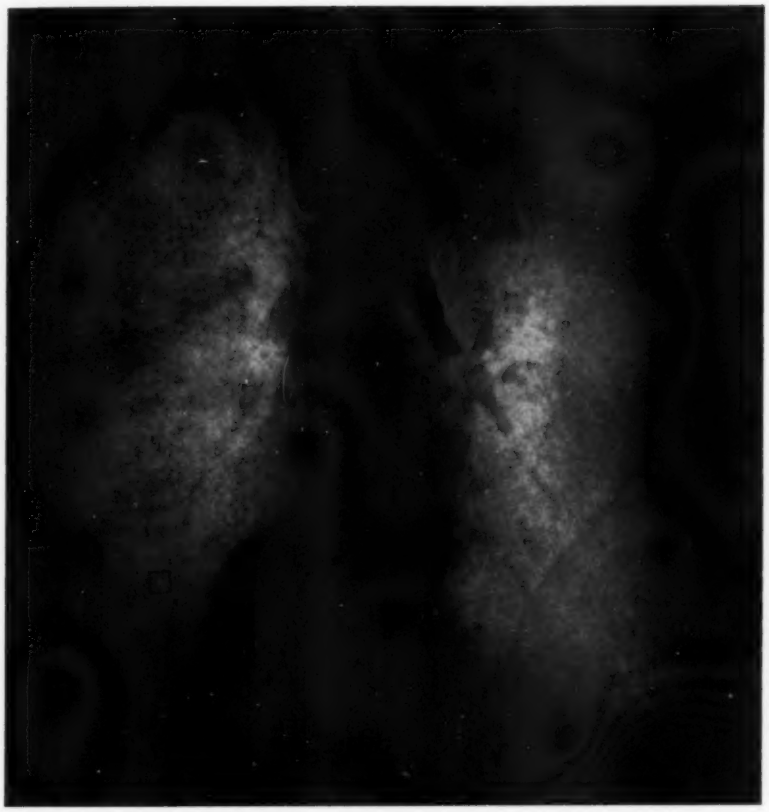
There is a primary tuberculous complex in a chalky calcified state, with a typical primary focus in the upper third of the left lower lobe. The minute calcified chalky tubercle in one regional bronchopulmonary lymph node was the only lymphogenous metastasis in this case. There was no further extension of the primary infection. Without the roentgenogram, this small complex change would probably have been missed.

PLATE II

Specimen from white female, 22 years of age. Cause of death: chromaffinoma.

This roentgenogram, like that reproduced in Plate I, shows a calcified tuberculous complex of primary infection. In this case, however, the relationship between the primary focus and complex changes is reversed, as compared with the former case. The primary focus is most minute, calcified, in the mid-third of the left upper lobe near the interlobar fissure. The regional lymph-node changes are comparatively extensive and involve the bronchopulmonary and upper tracheobronchial group. (In this case the right lung was in part dissected before the roentgenogram was made.)

PLATE III



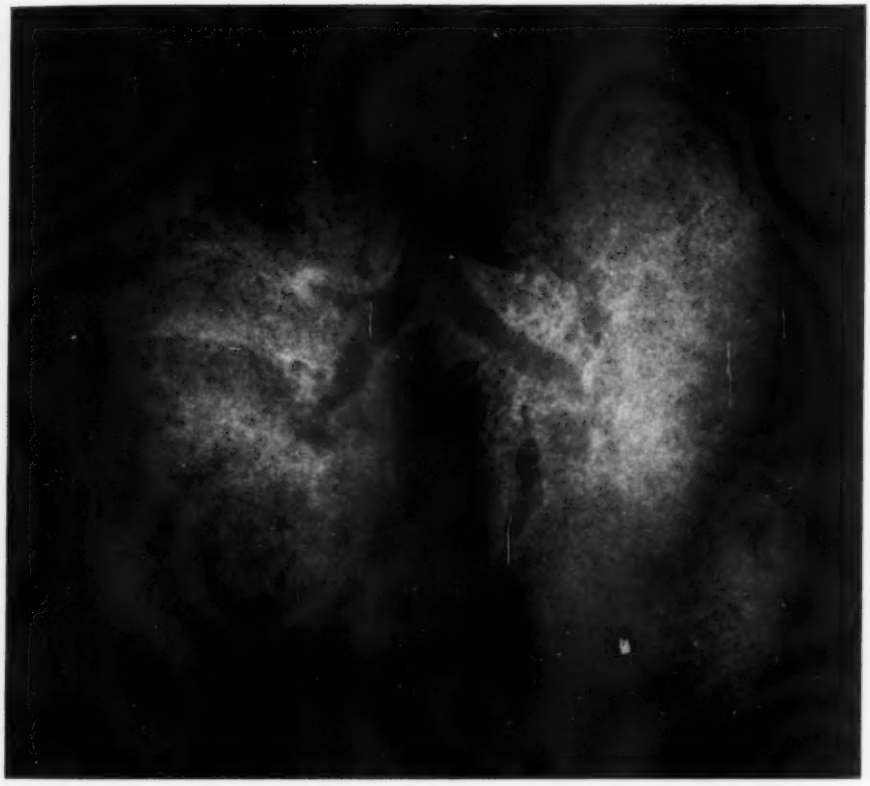
Specimen from a 33-year-old white female. Cause of death: bacterial endocarditis. In this case there was no anatomical trace of any tuberculous infection. The two minute calcified nodules, one in the subapical area of the right upper lobe, the other in the right lower lobe, proved to be typical phleboliths in their histologic structure.

PLATE IV

Specimen from a 73-year-old colored male. Cause of death: progressive pulmonary tuberculosis.

There are two firm, stony, ossified complexes of primary infection in the hilar area of the left lung and in the right lower lobe. The primary focus on each side is split up into multiple small fragments. In the lymph nodes in the left hilum, belonging to the left bronchopulmonary group, there is considerable anthracosilicosis combined with calcified tuberculosis. Most of the left upper lobe showed diffuse caseated pneumonia. The tuberculous process in the right lung was of more nodular peribronchial type. Tracheobronchial and paratracheal lymph nodes on both sides showed massive caseation.

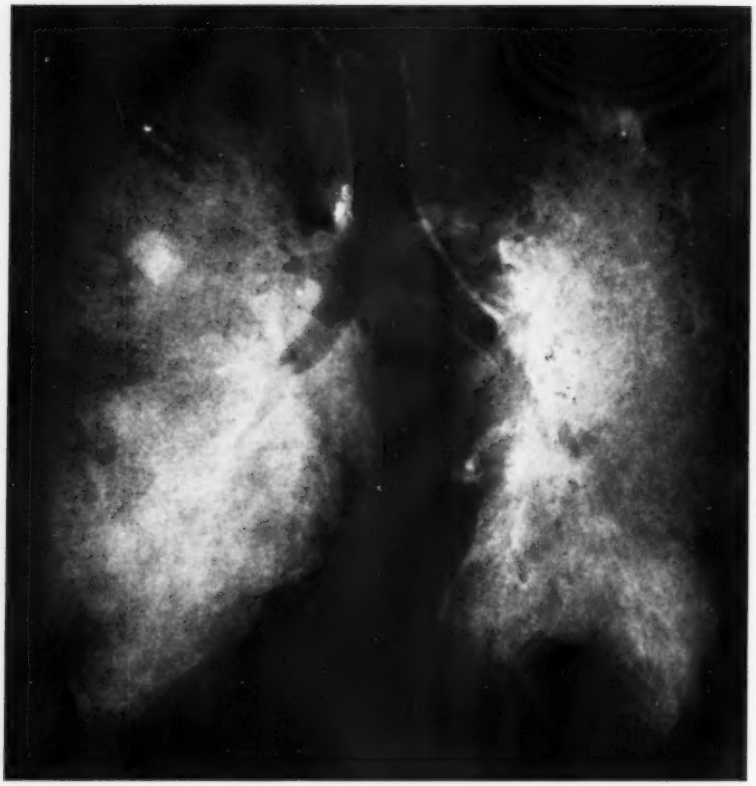
PLATE V



Specimen from a 47-year-old colored female. Cause of death: miliary tuberculosis in association with a caseous tuberculosis of the lumbar spine.

In this case there was no evidence of a primary complex formation. In the right apex fibrocaseated tubercles were found, with firm adhesions to the pleura. The small calcified nodule in the lateral part of the right lower lobe proved to be a phlebolith. The unusually dense miliary tuberculosis throughout both lungs is clearly demonstrated.

PLATE VI

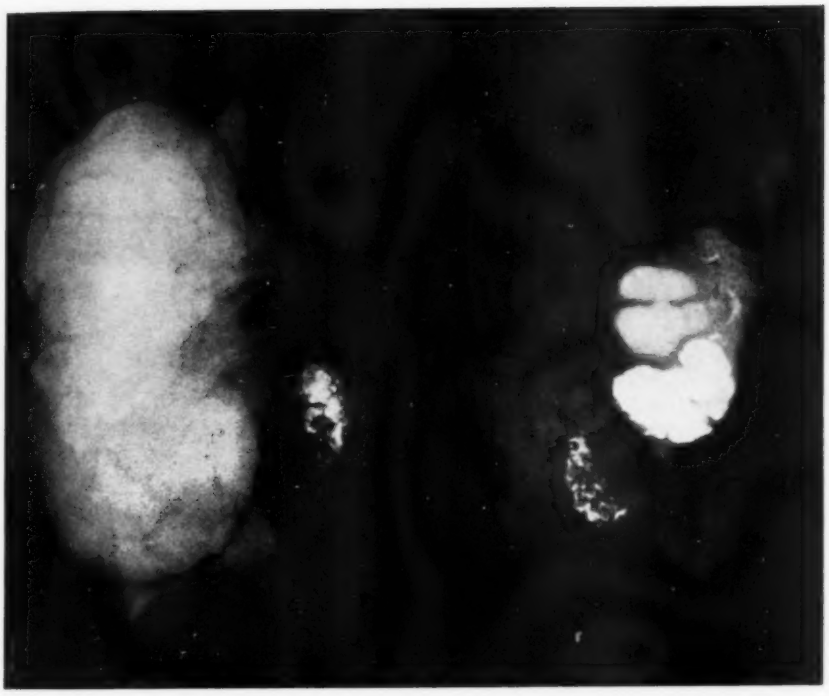


Specimen from a 60-year-old white male. Cause of death: Hodgkin's disease of liver, spleen, and retroperitoneal lymph nodes.

This roentgenogram shows an old calcified primary complex with the primary focus in the subapical area of the right upper lobe and with firm calcification of two lymph node groups, one bronchopulmonary node, and several upper tracheobronchial nodes on the right side. A small lymph node between the right upper and right middle lobes showed also a minute calcified tubercle.

The large globular shadow in the lower field of the right upper lobe was a huge caseated focus of reinfection. The regional bronchopulmonary lymph nodes, including the calcified tubercle in one bronchopulmonary node at the hilum, showed anatomically diffuse caseation. This is noticeable immediately to the right of the single calcified tubercle at the angle formed by the upper and lower main bronchus.

PLATE VII



Application to the kidney and surrounding structures of x-ray technic used in lung studies. This unusual roentgenogram was obtained at the death of a 51-year-old white male, from coronary thrombosis. He had been treated for a kidney stone for some time preceding his death.

The right kidney was almost entirely transformed into a firm, calcified chalky structure, with its upper half completely replaced by a chalky stone. Both adrenal glands showed distinct calcific, fibrous, chalky tuberculosis. There was also localized calcific atherosclerosis of the abdominal aorta. Note the compensatory hypertrophy of the left kidney. The ureter was completely obliterated. (More detailed discussion of this unusual finding will be published later.)

This chronic tuberculosis of the right kidney was metastatic to an otherwise typical exogenous reinfection tuberculosis in chalky fibrous state in the left upper lobe. A nodule in the subapical area of the left lung was likewise an old calcified tubercle, apparently secondary to the primary lesion or the effect of an old superinfection.

Factors Influencing Mortality in Head Injury[1]

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IT HAS LONG BEEN recognized that the most important factors in a given case of head trauma are the location and severity of the brain injury. A great deal of attention has consequently been paid to that phase of the problem, and, while much remains to be elucidated and there is a great deal of confusion in the literature in the usage of such terms as concussion and contusion, we do have much important clinical and experimental information on brain injury. As has been pointed out elsewhere (Voris, Verbrugghen and Kearns), however, an estimate of the degree and extent of the injury to the brain at the time the patient first comes under observation is often difficult if not impossible. A simple clinical classification that may be applied at this time has been suggested. This classification groups the patients as follows: (*a*) moribund; (*b*) gravely injured; (*c*) mildly injured; (*d*) complicated cases. Any cases in the first three groups, even in group *a*, may fall into the fourth group of complicated cases because of associated injuries, old age, or pre-existing disease or debilitation. Thus in actual experience it early becomes apparent that there are many other factors influencing mortality besides the primary ones of the location and severity of the brain injury.

Of these various factors, probably the most important is the age of the patient. During the four-year period, 1939–1942, inclusive, 2,714 cases of head injury were cared for on the author's neurosurgical service at the Cook County Hospital. There were 298 deaths in this group, a gross mortality rate of 11 per cent. Table I gives the distribution of these cases by decades with the mortality rate for each decade. This shows the great importance of the age of the patient in determining his chances for recovery. The older patient with a head injury is, of course, subject to many complications that a younger person is less liable to suffer from. These include hypostatic pneumonia, cardiovascular-renal complications, and late cerebral vascular changes. Then, too, the elderly patient who is admitted to a charity hospital is often debilitated and ill-nourished. Still another factor seems to be of great importance, namely, the impairment of the circulation of the brain in many elderly persons, with consequent poorer reparative response to injury. Reference to Table I shows there was a considerable group (300 cases) of severely injured derelicts in whom the exact age was never ascertained. As might be anticipated, this group showed the highest mortality of all, almost three times that for the entire series.

TABLE I: AGE DISTRIBUTION OF 2,714 CASES OF HEAD INJURY

Decade	Total Cases	Dead	Mortality Rate
10–19	141	7	5.0%
20–29	332	16	4.8%
30–39	502	25	5.0%
40–49	548	45	8.2%
50–59	486	49	10.1%
60–69	281	39	13.9%
70–79	109	25	22.9%
80–89	15	3	20.0%
Unknown	300	89	29.7%
TOTAL	2,714	298	11.0%

Fracture of the skull has, especially in the past, received undue emphasis in cases of head injury. One writer (Mock) has gone so far as to use the presence or absence of fracture of the skull as a so-called "yardstick" for evaluation of the seriousness of head injury and has confined his statistical analyses to proved cases of skull fracture. Many men responsible for the immediate care of head injuries deem it their duty to obtain immediate roentgenograms of the skull, no matter what the

[1] From Loyola University Medical School and the Cook County Hospital, Chicago, Ill. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Dec. 1–2, 1943.

physical condition of the patient or his ability to co-operate. The records of the coroner's physician of Cook County for several series of necropsies on patients dying of head injury show that in 30 to 40 per cent of such cases no fracture of the skull is demonstrable at the postmortem table.

Unfortunately the coroner's physician did not find it possible to perform necropsies in all of the 298 deaths in the present series of head injuries from the Cook County Hospital. Complete examination of the intracranial cavity and its contents was carried out in 120 cases (Table II). In 52 of these (43.3 per cent)

TABLE II: SKULL FRACTURE IN 2,714 CASES OF HEAD INJURY

	Total Cases	Deaths	Mortality Rate
Fracture	635	105	16.5%
No fracture	2,079	193	9.3%
TOTAL	2,714	298	11.0%
Total necropsies	120 (40.3% of deaths)		
Skull fracture	68 (56.7%)		
No skull fracture	52 (43.3%)		

no skull fracture was found. This single fact effectively shows the lack of importance of skull fracture in prognosis in cases of head injury. In the entire series of 2,714 cases there were 635 patients in whom a skull fracture was demonstrated by roentgenograms, at the operating table, or by postmortem examination, or who presented presumptive clinical evidence of a basal skull fracture. By presumptive clinical evidence of a basal skull fracture we mean discoloration of one or both orbits developing twelve hours or more after the injury, discoloration over one or both mastoids (Battle's sign), bleeding from the nose (without evidence of nasal injury), or drainage of cerebrospinal fluid from the nose or ears. In this group of 635 cases of proved or presumptive skull fracture there were 105 deaths, a mortality rate of 16.5 per cent as compared to the mortality rate of 11 per cent for the entire group. This is surely not a significant difference, especially when it is contrasted with the

TABLE III: CEREBROSPINAL FLUID FINDINGS IN 797 CASES (29.4 PER CENT OF TOTAL)

	Total Cases	Dead	Mortality Rate
Total punctures	797	141	17.7%
Blood-tinged fluid	154	39	25.3%
Gross blood	157	59	37.6%
Xanthochromic fluid	130	19	14.6%
Clear fluid	356	24	6.7%
Increased pressure	363	88	21.5%
Normal or low pressure	434	53	12.2%

43.3 per cent absence of skull fracture in the 120 cases that were examined postmortem.

Our practice at the Cook County Hospital is to postpone roentgenography of the skull until the patient is conscious, cooperative, and out of danger. There are, of course, certain exceptions to this rule. These include compound depressed fractures, penetrating wounds of the cranial cavity, suspected middle meningeal hemorrhage, and fractures involving the nasal accessory sinuses. In compound depressed fractures and the special subvariety of these, penetrating wounds of the cranial cavity, roentgenograms of the skull should be made preoperatively to determine the nature and extent of the bony injury and the location of retained radiopaque foreign bodies. When middle meningeal hemorrhage is suspected, the presence of a fracture line crossing the vascular markings of the middle meningeal vessels is not only of diagnostic but also of localizing value, as it indicates the probable point of rupture of the artery. If fracture involving the nasal accessory sinuses is suspected, early roentgenograms are of importance in determining whether traumatic aerocele exists. With the above exceptions, the presence or absence of skull fracture is not of sufficient clinical importance to warrant attempts to obtain roentgenograms of the skull until the favorable circumstances referred to above are present.

Of much more prognostic importance than the presence or absence of skull fracture is the appearance of the spinal fluid. Diagnostic spinal punctures were done in 797 cases, or 29.4 per cent of our series (Table III). This group represented

more serious injuries than the series as a whole, for there were 141 deaths, or a mortality of 17.7 per cent, as contrasted to 11 per cent for the entire series. However, in the 356 cases in which clear fluid was found there were only 24 deaths (6.7 per cent), a mortality rate considerably less than that for the entire series. As the table shows, with the presence of blood in the spinal fluid the mortality rate is greatly increased, especially if the fluid is grossly bloody. In the latter case, either severe cerebral contusion or laceration may be assumed to be present.

Increased pressure of the spinal fluid as measured with a manometer on lumbar puncture is in itself a factor associated with increased mortality, as Table III shows, the mortality in such cases being 21.5 per cent as contrasted to 12.2 per cent in the cases showing normal or low pressure. Increased pressure means spinal manometric readings in excess of 140 mm. of water with the patient in the horizontal position and relaxed. In this connection it must be pointed out that a normal or low manometric pressure as measured from the lumbar subarachnoid space does not mean necessarily that intracranial pressure is normal. Partial block due to cerebral edema with or without foraminal herniation at the foramen magnum or the incisure of the tentorium may interfere with the transmission of cerebrospinal fluid pressure from the intracranial cavity to the lumbar subarachnoid space. In certain cases, because of swelling of the brain, the cerebrospinal fluid is squeezed out of the ventricles and cranial subarachnoid spaces. Neurologic surgeons sometimes have the experience of finding such a situation in deep-seated, infiltrating supratentorial tumors. In such cases, if the ventricles are tapped, only a few drops of fluid may escape under decreased pressure. Yet the brain may be under greatly increased tension and bulge markedly when the dura is opened. In its way, it is just as unfortunate to use the lumbar manometric pressure as a "yardstick" of intracranial pressure in head injuries as it is to use the presence or absence of skull fracture as a "yardstick" of the severity of the brain injury.

In 1,206 cases in the series there were associated injuries to other parts of the body. Table IV shows the distribution of these injuries (which in some cases were multiple) and the mortality for each group. Injuries to the face and extremities were by far the most frequent. The mortality rate, however, was not seriously influenced by the presence of these injuries. On the other hand, injuries to the chest, spine, or spinal cord, particularly to the cord, materially increased the mortality rate. Injuries to the chest add to the risk, especially in older people. It is our practice to get elderly patients out of bed as soon as their condition permits, regardless of subjective symptoms or of mental confusion. Another valuable procedure in the patient with chest injury is paravertebral novocaine or alcohol injection of the intercostal nerves supplying the injured area. This relieves the pain and anxiety and permits resumption of more normal respiratory excursions. It not only makes the suffering patient more comfortable but contributes to his chances of survival.

TABLE IV: ASSOCIATED INJURIES IN 1,206 CASES (44.4 PER CENT OF TOTAL)

	Cases	Deaths	Mortality Rate
Face	795	69	8.7%
Extremities	456	54	11.8%
Chest	156	32	20.5%
Abdomen and pelvis	53	5	9.4%
Neck	46	5	10.9%
Spine	28	5	17.9%
Spinal cord	7	3	42.9%
Peripheral nerves	2	0	0
Miscellaneous	17	3	17.6%

Pre-existing chronic disease was present in 383 cases, as shown in Table V. Cardiovascular and renal disease contribute the most to increased mortality. The mortality rate when tuberculosis was present was also higher than for the series as a whole, but the group of cases was very small, numbering only five.

Associated disease developing acutely is usually either meningitis or pulmonary infection. The frequency of these con-

TABLE V: ASSOCIATED CHRONIC DISEASE IN 383 CASES (14.1 PER CENT OF TOTAL)

	Cases	Deaths	Mortality Rate
Alcoholism	234	19	8.1%
Epilepsy	30	3	10.0%
Cardiovascular disease	65	18	27.6%
Nephritis	5	3	60.0%
Diabetes	18	0	0
Syphilis	26	2	7.7%
Tuberculosis	5	1	20.0%
TOTAL	383	46	12.0%

ditions in the 120 fatal cases that were examined postmortem is shown in Table VI. Pulmonary complications were by far the most frequent, occurring in 18.3 per cent of this group. Meningitis was present in 7 cases, or 5.8 per cent of the group. This corresponds well with other published figures, which give meningitis as the cause of death in from 3 to 8 per cent of fatal head injuries. In our entire series there

TABLE VI: ASSOCIATED ACUTE DISEASE IN 120 NECROPSIES

Meningitis	7
Pneumonia	18
Lung abscess	4
Cardiovascular-renal disease	9

were 20 cases of meningitis with 12 deaths, a mortality of 60 per cent. This falls far short of the ideal, but, on the other hand, the 40 per cent of recoveries represents a material gain over the death rate before the advent of sulfonamide therapy.

General prophylactic measures are of great importance in patients with scalp lacerations, compound fractures, bleeding from the ears or nose, and rhinorrhea or otorrhea. Thorough and meticulous débridement of all wounds involving the scalp and bone should be carried out, with excision of contaminated and devitalized tissue. If the dura is penetrated, the cerebral wound should be "débrided" by appropriate neurosurgical methods (using suction and irrigation). Foreign bodies should be removed if that does not entail damage to uninjured cerebral structures. These major neurosurgical procedures must be postponed, however, until the condition of the patient permits and proper operating conditions can be attained. The sooner they are carried out after the injury the better, but for the reasons stated it may be necessary to delay them for as long as seventy-two to ninety-six hours. The preoperative and postoperative administration of sulfonamides is of great value but must never be substituted for proper surgical treatment.

Patients with bleeding or drainage of cerebrospinal fluid from the ear or nose should be kept flat in bed. There must be no interference with the drainage, and irrigations are strictly contraindicated. Sulfonamides, preferably sulfadiazine, should be administered prophylactically during the period of drainage and for at least seventy-two hours thereafter. Drainage of cerebrospinal fluid from the ear almost always stops spontaneously within forty-eight hours; drainage from the nose usually does so. It if does not cease within a few days, plastic closure of the dural defect should be carried out through a transfrontal craniotomy, the condition of the patient permitting. This should be undertaken only by a competent neurosurgeon under proper operating conditions.

Fractures involving the frontal sinus with external compounding of the wound call for operation, like other cases of compound fracture. Where external compounding of the wound has not taken place, the patient must be watched carefully and roentgenograms be taken repeatedly. If pneumocephalus develops, immediate operation is indicated, with repair of the dural defect through a transfrontal craniotomy, as in cases of persistent rhinorrhea.

When a patient who has suffered a head injury shows signs of meningitis, spinal puncture should be done at once If there is a pleocytosis, sulfonamides should be used in massive doses. Daily blood counts and sulfadiazine levels should be determined. Lumbar puncture should be performed at intervals of one to three days until the cell count is normal and cultures are sterile. Therapy should be continued several days after the patient has clinically recovered and the cerebrospinal findings are normal. Penicillin offers great

promise in the treatment of post-traumatic meningitis. Perhaps we may yet equal or improve upon the goal of a 25 per cent mortality set by Grant.

SUMMARY

1. The location and severity of the brain injury are the most important factors influencing mortality in injuries of the head.

2. Next in importance is the age of the patient.

3. The presence or absence of skull fracture is not of importance except in compound fractures, depressed fractures, fractures involving the middle ear or nasal accessory sinuses, and fractures causing a tear of the middle meningeal artery or one of its branches.

4. The presence and amount of blood in the cerebrospinal fluid are an important prognostic sign. When lumbar spinal pressure is increased, the mortality rate is higher, but lumbar spinal manometric readings do not always give a dependable indication of intracranial pressure.

5. Associated injuries, especially of the chest, spine, or spinal cord, significantly increase the danger to the patient's life.

6. Associated disease does likewise, particularly cardiovascular-renal disease and acute pulmonary complications.

7. Meningitis is relatively rare but has a high mortality and must be treated promptly and energetically if the patient is to survive.

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Revascularization of the Carpal Bones[1]

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with

WM. R. CUBBINS, M.D., F.A.C.S., MAJ. CARLO S. SCUDERI, M.C., and CAPT. EUGENE HAMILTON, M.C.

THE INCREASE in interest in fractures of the carpal navicular and lunate bones is evidenced by the large number of articles that have in recent years appeared in literature. Unsatisfactory results have always stimulated the profession to try new methods. In this instance there is an added stimulus, namely, industrial and military.

The history of the treatment of carpal fractures parallels that of fractures of the neck of the femur. The causes of failure are similar, namely, interference with the blood supply, inadequate fixation, and intra-articular fracture, the exception being, of course, fracture of the tuberosity of the navicular. The treatment is similar in that it consists of long immobilization in plaster, drilling, pegging, and finally, in many instances, excision.

For the past eight years or more we have studied many carpal injuries, with special attention to the circulation. As is well known, the circulation to the carpal bones is through their ligamentous attachments (Fig. 1). The blood supply of the carpal navicular is through the foramina at its ligamentous attachments. The two main areas are the tubercle and the waist. The proximal pole does not have a good blood supply. Nutrition of the lunate is derived from the dorsal and volar surfaces of the wrist through the foramina. It is thus readily understandable why, in dislocations where the dorsal surface is interfered with, the patient still has circulation in the volar surface. In some cases where the lunate has been dislocated for weeks or months there may be only a minor difference in density; this indicates that some circulation is present, and the dislocation should be reduced. The prognosis as to the ultimate outcome depends entirely on the degree of dislocation and the interference with the circulation. Where the blood supply is completely cut off, aseptic necrosis or Kienböck's disease usually develops (Fig. 2).

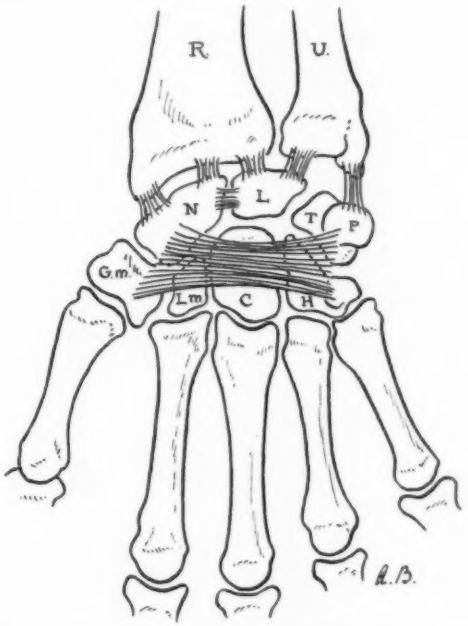

Fig. 1. Ligamentous attachments of the carpal bones.

Fractures of the navicular are divided, on the basis of their circulation, into three groups. (1) Fractures of the tubercle show a high percentage of bony union because of the adequate blood supply. (2) Fractures of the waist, or circular portion, usually heal if properly immobilized over a long enough period. Frequently incomplete fractures in this area are missed unless enough roentgenograms are taken at the time of injury. Even then it is many times difficult to demonstrate a fracture, and only

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

Fig. 2. Dislocation of lunate, of months' duration. There is no difference in density because the volar circulation is still intact.

later will re-examination, because of the continuation of clinical symptoms, reveal absorption at the fracture line and lead to the correct diagnosis. Healed fractures may be manifested in the form of residual central necrosis. (3) Fractures of the proximal pole, because of inadequate circulation, often fail to unite. Bony changes ensue and it is necessary to excise the fragment. In the presence of small fragments of the proximal pole many authors advise early removal, before arthritic changes occur. Better functional results are usually thus obtained, while with long periods of immobilization these cases usually fail to respond to treatment.

Accompanying dislocation and associated soft-tissue lesions usually increase the incidence of vascular disturbance. In such cases manipulation should be done with care because of the danger of further circulatory interference. If a reduction cannot be obtained, it is better to perform an open operation and carefully reduce the fracture dislocation rather than to continue with vigorous manipulation. The ligamentous structures should be accurately repaired in order to aid in the restoration of the blood supply. If properly reduced, the greater percentage of fractures and dislocations will heal, but frequently the intercarpal ligamentous attachments fail to reform with normal firmness and a separation or partial rotation of the involved bones results. This may lead to arthritic changes followed by disability.

Various stages of revascularization can be observed following either open or closed reduction of these fracture dislocations. This includes fracture dislocations of the navicular and dislocations of the lunate carpal bone. An example is dislocation of the lunate carrying with it the proximal fragment of the fractured navicular. This fragment is firmly attached to the dislocated lunate by the intercarpal ligament and, after reduction either by the open or closed method, usually undergoes circulatory changes. These changes are reflected by the difference in density in comparison with the other carpal bones (Fig. 3). This is the most important time in the treatment of this serious injury. Doctor Cubbins has called this fragment "dormant" bone, because it is in the stage awaiting necrosis or revascularization. The invasion of the necrotic fragment is indicated on x-ray examination by loss of bone density and formation of "bone cavities," first seen adjacent to the fracture site. This is the earliest clinical evidence of bone repair. Phemister has described this beginning revascularization and transformation as "creeping substitution."

The slight degree of arthritic change occurring in both the wrist and the carpal bones is astonishing considering the prolonged interruption of blood supply and lack of nutrition to the injured bones. One would expect degeneration of the hyaline cartilage overlying the fracture or dislocation to be rather extensive, but in most cases this complication has not been apparent except as evidenced by a slight indentation at the fracture site. This indentation usually occurs directly opposite the radial navicular articulation, especially if the fracture is not accurately approximated. Arthritic changes will invariably occur in this area.

Fig. 3. A. Fracture dislocation of navicular with dislocation of lunate, six weeks old. B. Same case after open reduction (three months old). Note vascular changes evidenced by difference in density.

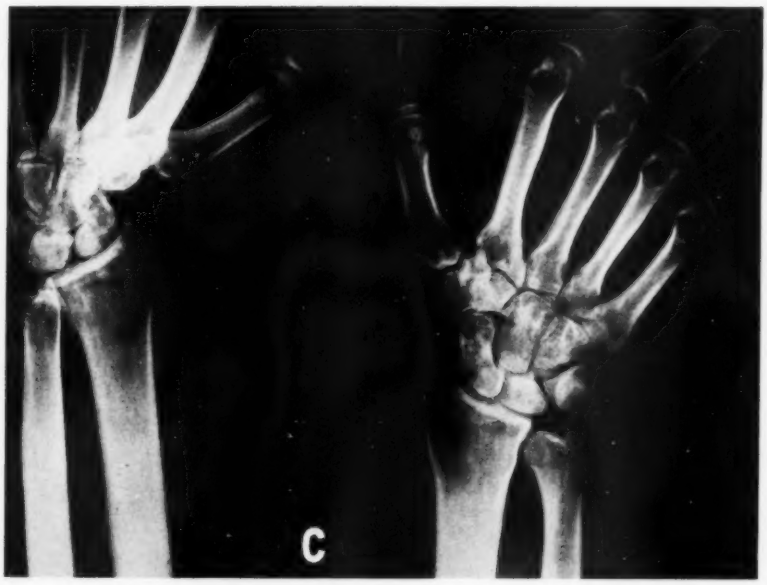

Fig. 3. C. End-result of case shown in Fig. 3, A and B, after two years.

Complete revascularization of the fracture or/and dislocation takes from nine to twelve months and sometimes longer. We have observed cases requiring as long as two years for completion of the process. In some of the cases treated, revascularization required nearly as long in the child as in the adult. In one instance where only a

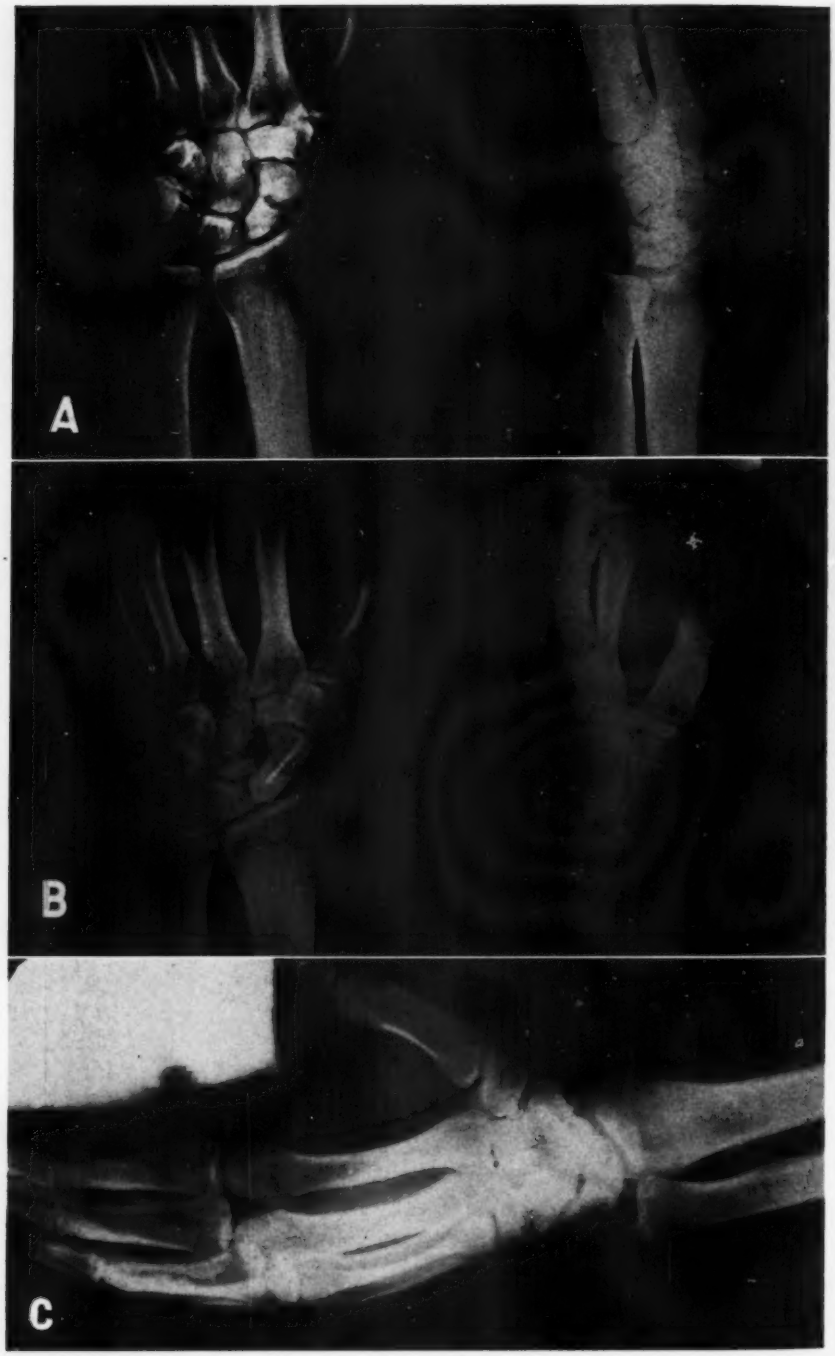

Fig. 4. A. Ununited fracture of navicular, eighteen months old. B. Postoperative view, five months old. C. End result. Note rough articular area on navicular at old fracture site.

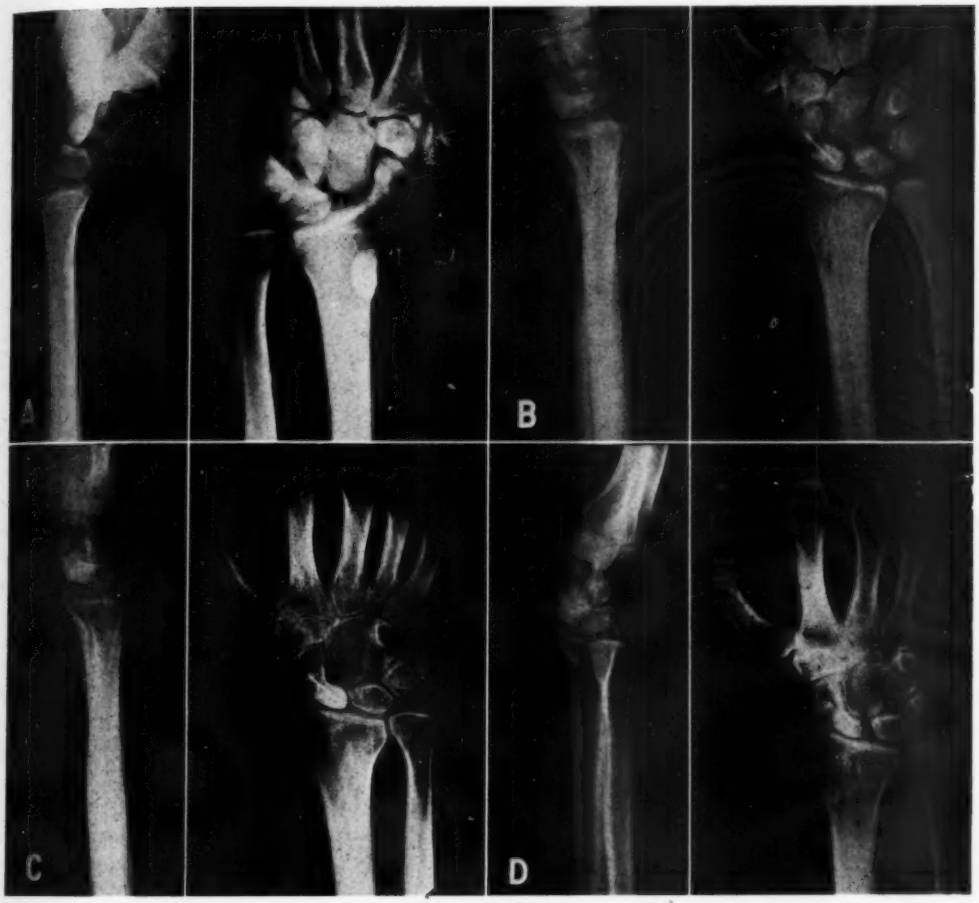

Fig. 5. A. Fracture dislocation of carpal navicular. B. Open reduction with immobilization by bone peg from radius. Note that the reduction is not accurate and vascular changes are present. C. Beginning bony union six months later. D. End result, three years later. Note arthritic changes at radius, possibly due to inaccurate reduction.

fracture of the navicular occurred in a fifteen-year-old boy, over nine months' immobilization was necessary before complete union occurred. This was due to the severe soft-tissue damage accompanying the fracture, interfering with the circulation to the carpal bones.

Fractures of the navicular may be seen following epiphyseal separations in children and, while this is not common, it should not be overlooked. Following reduction of the epiphyseal separation the neutral position is preferable to ulnar deviation because of the danger of separating the proximal and distal fragments of the navicular carpal bone. Longer periods of immobilization are required because of the fractured navicular than would ordinarily be necessary for the epiphyseal separation.

Recently there has been an increase in the number of comminuted fractures of the radius and ulna complicated by carpal injuries. This serious condition usually requires a long period of immobilization. It produces vascular interference, resulting in functional disability and post-traumatic arthritis and/or osteoporosis of the navicular or Preiser's disease, and, if it involves the lunate, Kienböck's disease. It is necessary in these cases to reduce the

comminuted fracture and the accompanying carpal lesion and immobilize in the neutral position.

In cases of non-union of the navicular with clinical symptoms, where no cystic changes have occurred and where the arthritic changes are minimal, it has been our custom to freshen the fracture site and to secure it by a bone peg in order to obtain adequate reduction and immobilization (Fig. 4).

Following the pegging we frequently see changes of density caused by circulatory disturbances. These changes usually disappear with healing of the ligamentous structures followed by revascularization, though many months are required before the process is completed, resulting in a useful, painless, and functional wrist. Patients so treated should be able to resume their former occupations, and many have been able to carry on during the period of immobilization.

With fractures of the navicular accompanied by a wide dislocation or separation of the fragment, either proximal or distal, the question arises whether these fragments should be excised or replaced. This, I believe, is an individual problem depending on the amount and extent of soft-tissue damage and the site of the fracture (Fig. 5). An economic question also enters—would the patient be better off to have the fragment removed, accepting the disability and an early return to employment, or should the fragment be replaced followed by a long period of immobilization awaiting subsequent circulatory improvement.

In painful bipartite naviculars, success has been obtained by bone pegging, followed by immobilization. These carpal bones do not display the same amount of vascular change that is seen following fractures, as their circulation is usually not disturbed by severe trauma, and bony union occurs in a shorter period of time.

In conclusion, I would like to stress the following points:

1. Early rigid immobilization of fractures of the navicular should result in union if the circulation is within normal limits. If the proximal pole does not tend to unite, it should be removed early, before arthritic changes develop in the wrist joint.

2. Bone pegging or drilling of the navicular with cystic changes should be discouraged, as these cysts, even after packing with cancellous bone, usually do not heal, and arthritic changes occur.

3. Complete dislocation with a minimum amount of trauma requires early reduction and immobilization. In those cases which cannot be reduced by manipulation, operation should be performed and the ligamentous structures repaired.

4. In comminuted fractures of the wrist complicated by carpal injuries, the fractured radius and ulna should be reduced and the carpal bones reduced and held or immobilized in the neutral position. A guarded prognosis should be given because of the circulatory changes involving the carpal bones.

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Close-Range Technic in Diagnostic Roentgenology[1]

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THE FUNDAMENTAL problem in roentgenography, according to the clear formulation of Weyl, Warren, and O'Neill is the selection of technical procedures which will produce roentgenograms having minimum observable unsharpness and predetermined average densities and contrasts. The solution of the problem in each case is dependent upon the exposure factors, such as the correct voltage, exposure time, and focal-film distance, and a combination of auxiliary devices, as cones and Potter-Bucky diaphragm (1). We are concerned, in the present paper, with but one of these factors, the focal-film distance.

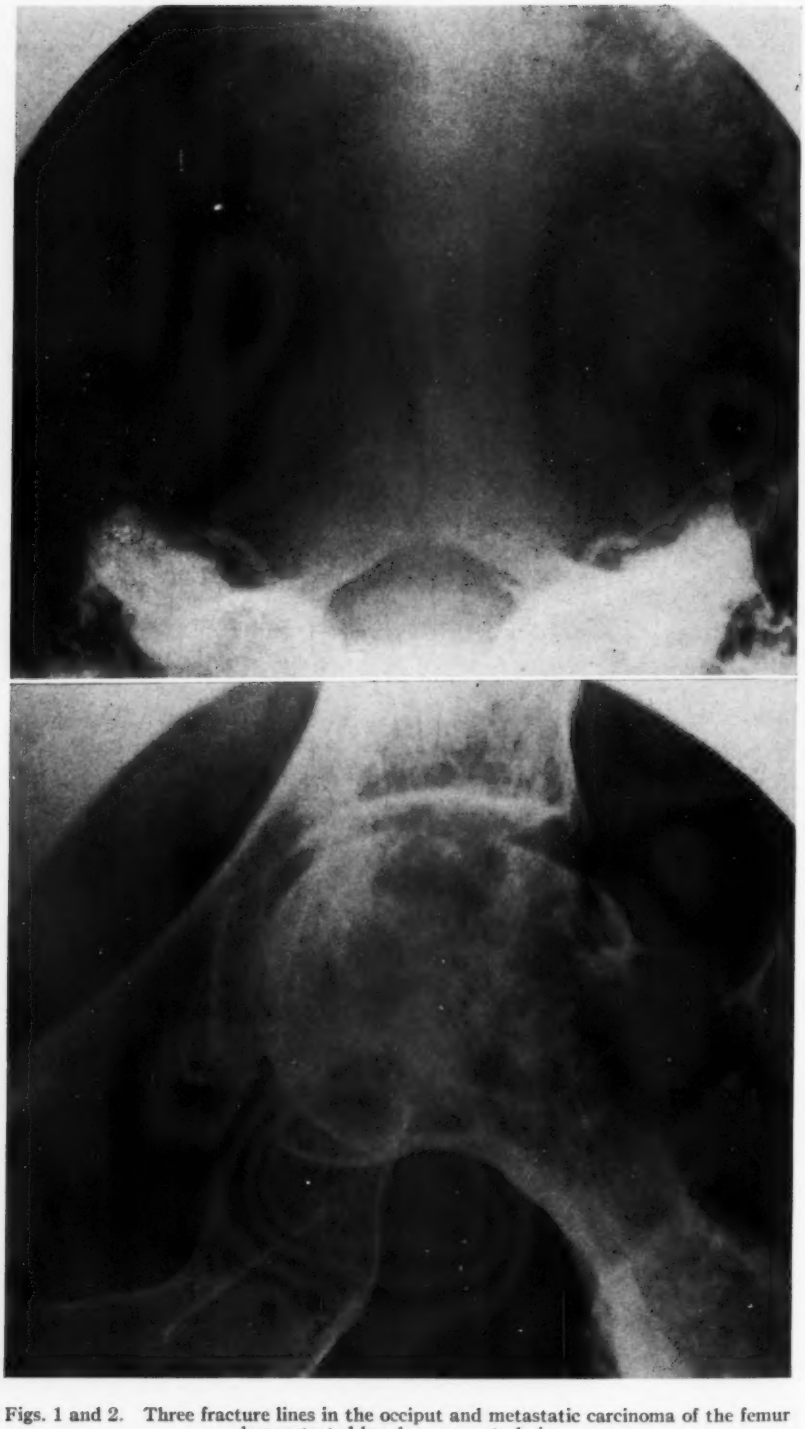
In order to obtain a point source of x-rays and reduce the unsharpness of the image due to the size of the focal spot, it is commonly considered necessary to place the tube at a distance of 30 to 36 inches from the film. As the object-film distance increases, the focus-film distance must also be increased to insure the maximum definition. At an object-film distance of 2 inches and a focal-film distance of 2 feet, the distortion measures 9.05 per cent. At the same object-film distance, but a focal-film distance of 6 feet, the distortion is only 2.85 per cent. Decreasing the film distance increases and enlarges the shadow of the object which is not in direct contact with the surface of the film, increases the peripheral zone of the penumbral shadow, and causes distortion and lack of detail. The customary practice, therefore, is to take films from the greatest practical distance. A chest film is taken usually at 4 feet. For measuring the exact size of the heart, a film taken at 6 feet is regarded as necessary, and a similar long-distance technic is described by many roentgenologists for the spine and the skull.

In contrast to such well established rules, we find the occasional empirical use of what we may call "close-range technic." Even before the advent of the high-tension protected x-ray tube, we see one writer (2) empirically using a close-range technic for demonstration of the temporomandibular joint, and there are probably other instances where such technics may have been used. The *Cumulative Index* of the American Medical Association for the last few years makes no mention, however, of such technic, and it seems never to have been generally accepted.

The principal use of the close-range technic is for the demonstration of bone lesions wherever a fine analysis of a localized structure is required and where such a lesion is not too distant from the surface. The procedure consists in placing the tube either directly in contact with the part to be examined or, as we prefer in practice, with the interposition of a very short cone. We find a distance of 10 to 15 inches between the focal spot and the surface of the body the most suitable and use the shortest and narrowest cone available, just sufficiently wide to permit visualization of the line or structure in question. The exposure is reduced, 1 or 2 kilovolts less than at the conventional distance, with the same screens. The exposure time is diminished according to the inverse square law. It might be expected that such a technic would result in a loss of detail, distortion, and loss of contrast. Actually the part which is exactly traversed by the central ray is exceedingly clear, especially in bone work, and we believe that the trabeculation of the bone, acting like a Potter-Bucky grid, contributes to the sharpness of the image.

Toward the periphery, if the field is large, the unsharpness and the distortion increase. Therefore, exact centralization over the suspected area and a small cone

[1] Accepted for publication in April 1944.



Figs. 1 and 2. Three fracture lines in the occiput and metastatic carcinoma of the femur demonstrated by close-range technic.

are necessary. It is important that the object to be examined should be as near as possible to the film to avoid further enlargement and distortion. It is probably for that reason that the method proves especially valuable in the visualization of the temporomandibular joint, in fractures of the convexity of the skull, and in the demonstration of the sternum.

Fig. 3. Osteochondritis dissecans. Two small osteochondritic bodies are seen in their bed in the medial condyle. The sclerotic envelope and the sequestra are clearly visible in close-range films.

The enlargement of a circumscribed object is not objectionable. To see a pathological lesion in the ribs or in the skull, such as a tuberculous focus or myeloma, *enlarged* is quite frequently a distinct help in diagnosis. The close-range film should be taken after localization of the lesion on a scout film, to show the finer structures, sequestrations, and breaking down of cell walls. The technic further frequently permits the use of special high-definition and even non-screen films without undue prolongation of the exposure factors. Using a rotating anode tube or a fine focus, we have often obtained exceedingly sharp pictures over a circumscribed area, affording a more definite answer to a puzzling roentgenologic question. Such problems as the differentiation between vascular channels and a fissure fracture of the skull,

Fig. 4. Kidney carcinoma. Pressure upon the calices was visible on a conventional film, but tumor invasion of the kidney pelvis was clear only in a close-range film.

the search for osteomyelitic sequestra, the demonstration of loose bodies in the knee joint and their site of origin and of changes in the mandibular and clavicular joints are a few of many where the technic has proved valuable. Even in mastoiditis close range technic in addition to the conventional method has certain advantages, giving an enlarged and clear view of the state of the cell walls and the architecture of the cell system, which is more important than a knowledge of the correct size and shape of these cells.

It appeared doubtful whether the close-range technic could be used for examination of the gallbladder and kidney for the presence of stones, but we have found that this technic frequently gives a clearer view of the gallstones; that it may bring out more gallstone shadows than were first seen on the conventional film; and that the kidney calices and small stones in that area are more clearly seen and defined than on the primary survey film.

We were hesitant to use the close-range technic for identification of lung densities. Here, distances of 1.25 to 2 meters, are considered necessary to minimize shadow enlargement and avoid haziness. We first

Fig. 5. Gallstones as demonstrated by close-range technic. The centered close-range film brings out the details of stone structure, showing the dense center, translucent area, and faceted surface.

tried the method in the identification of fine apical shadows and found it valuable in the detection and analysis of such minor tuberculous densities and adhesions. We then proceeded to examine small areas of hilum and lung in the hope that it might be possible to attribute demonstrable lesions more definitely to the three systems of the lung (bronchus, vessels, and lymphatics), but our work in that line is still too limited for presentation at this time. We feel, however, that too much emphasis is given, in roentgenologic analysis and in reproductions, to the full picture of the lung, and not enough to the minute detail which is frequently more instructive than the life-size film. As in gastric roentgenography, spot films taken at close range over a suspected area are desirable.

SUMMARY

A close-range technic is advocated as a supplement to the conventional film for the examination of suspected lesions, such as sequestra, fractures of the convexity of the skull, osteochondritis dissecans, meningioma, inflammation of the temporomandibular joint, and other conditions where a finer analysis of a circumscribed area of bone destruction is required.

Fig. 6. Osteomyelitis. Sequestration, involucrum, and cloaca are clearly visible in this close-range film.

While the peripheral zone is indistinct and distorted, the combination of a fine focus, small cone, and high-definition screens gives an enlarged but distinct picture of the central area. A grid effect of bone trabeculation is believed to diminish the scattered radiation.

The principle of close-range technic has a wide field of application. It is not confined to the temporomandibular joint or even to the skeletal system but can be used to good advantage, also, in the detection of gallstones, kidney stones, and renal abnormalities, as well as in the analysis of various lung densities.

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CASE REPORT

Calcification of Infarctions of the Myocardium[1]

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Calcification of the heart muscle was first demonstrated during life, roentgenologically, by Groedel (1), in 1911. In 1924 Scholz (2) published a case which was followed up by autopsy study. Cohen and Levine (3) reported a case in 1937, and in 1938 Parkinson (4) added another, giving an excellent historical review of the subject, with comments on clinical and roentgenographic features of the disorder. In 1943, Borman (5) presented a case with x-ray, kymographic, and electrocardiographic observations and called attention to the logical deduction that calcification within the heart takes place only in dead or markedly deteriorated but never in healthy myocardium. This opinion was substantiated by Hanes (6) in his account of a patient who died from parathormone intoxication, exhibiting at autopsy severe degenerative lesions of the myocardium containing deposits of calcium. This condition had been previously described by McJunkin, Tweedy, and Breuhaus (7).

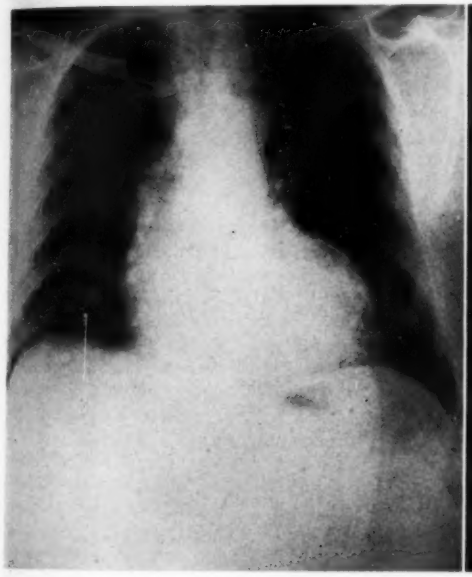

Fig. 1. Postero-anterior film of chest showing the bulge in the upper portion of the left ventricle with the calcified shadow beneath the pericardium.

Fig. 2. Lateral view of the chest showing the lesion illustrated in Figure 1 situated in the anterior portion of the left ventricle.

The following case is reported because it presents three features of exceptional interest. First, the calcification obviously is present in a myocardial infarction which occurred twenty-two years previously, in a patient still carrying on a useful life. Second, the aneurysm was suspected clinically and demonstrated roentgenographically. Third, the patient was approved as a surgical risk because of the absence of congestive heart failure and

[1] From the Departments of Internal Medicine and Radiology, Bowman Gray School of Medicine of Wake Forest College and the North Carolina Baptist Hospital, Winston-Salem, N. C. Accepted for publication in May 1944.

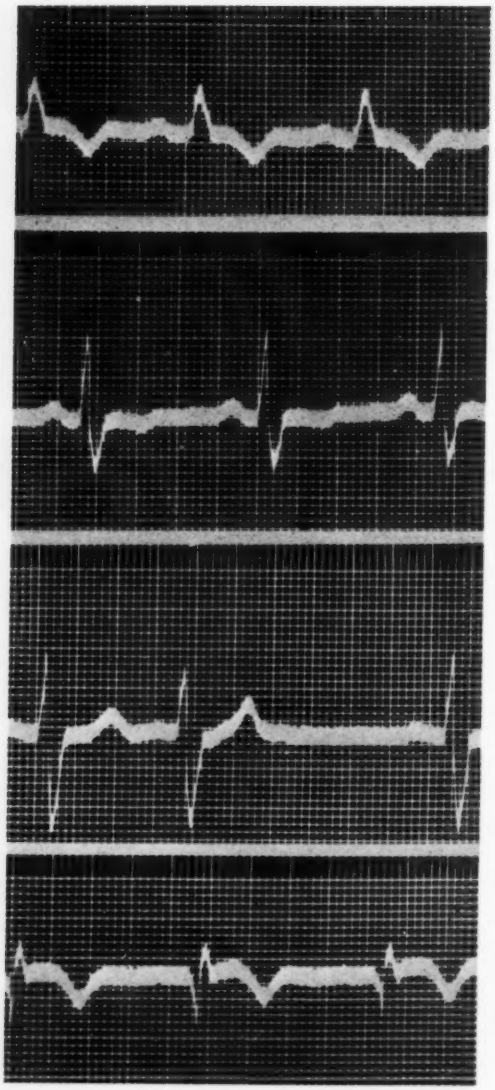

Fig. 3. Electrocardiogram showing the typical findings of an old infarction of the anterior portion of the left ventricle, and also a delay in the intraventricular conduction. Standard limb leads and CF_4.

withstood transurethral prostatic resection without difficulty.

At the time of this observation, in 1943, the patient was 62 years old and his admission to the North Carolina Baptist Hospital was occasioned by moderate but progressive prostatic obstruction, with 60 c.c. of residual bladder urine. The past history revealed an attack of severe substernal pain which radiated to the neck and jaws and out both arms to the elbows, occurring twenty-two years earlier, when the patient was forty years of age. The pain lasted several hours, being relieved only after two hypodermics, and the patient was confined to bed for four weeks. He returned to his work as a civil engineer, which he followed under definite physical restrictions without disability, except for slight dyspnea on exertion, up to his present illness.

The patient was seen in consultation by one of us (R. L. M.) for evaluation as a candidate for operation. Physical examination showed a well developed and well nourished man not objectively ill and with no significant findings other than those related to the cardiovascular system. There was mild (grade I) arteriosclerosis. The lungs were clear. In the second left intercostal space, 7 cm. from the midsternal line, was a rocking, forcible impulse slightly preceding the apex impulse. The latter was felt in the fifth left interspace, 10 cm. from the midsternal line. The heart sounds were of good quality, and only a slight systolic murmur was heard at the apex. The liver was not palpable and there was no edema of the extremities. Aneurysm of the left ventricle was suspected on the basis of the abnormal pulsations, and this clinical diagnosis was confirmed by roentgenographic study.

The roentgenological findings in this patient were typical of calcification in the wall of a previous myocardial infarction with left ventricular aneurysm.

Fluoroscopic examination showed a distinct rounded bulge in the left ventricular contour craniad to the left lower pole, which was inseparable from the cardiac shadow in all positions. In the right antero-oblique view, this bulge extended ventrally to the inner border of the sternum. The aorta was moderately dilated, elongated, tortuous, and sclerotic. The lungs were clear.

The pulsations of the ventricle at the site of this bulge were greatly reduced in amplitude and barely perceptible. In addition, a half circle "cup-shaped" ring of calcium, similar to that described by Roesler (8), 2 to 5 mm. in thickness, was seen to encircle the dilated sac. Postero-anterior and lateral films (Figs. 1 and 2) confirmed the screen findings and definitely determined the site of the calcium to be within the myocardium, and not situated at the usual sites of calcium deposits in the pericardium, annulus fibrosus, mitral or aortic rings, or interventricular septum, as described by Sosman (9). The electrocardiogram showed evidence of an old anterior type of infarction of the left ventricle (Fig. 3). The remaining accessory clinical data were normal.

Transurethral prostatic resection was performed under caudal anesthesia and the patient's operative and postoperative courses were uneventful.

While this case has not been studied at autopsy as were the four cases referred to above, we feel that the history, physical

examination, and electrocardiographic findings lead to the diagnosis of myocardial infarction and myocardial aneurysm. X-ray studies demonstrated beyond any doubt the presence of an aneurysm of the left ventricle in which calcification was present.

The finding of such an unusual cardiac pulsation as described above, in the absence of acquired or congenital valvular or other deformity of the heart, should lead one to suspect aneurysm of the left ventricle. This clinical diagnosis must be confirmed roentgenologically.

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EDITORIAL

The Lethal Effect of Whole Body Roentgen Irradiation in Animals

From the earliest days of radiology, the lethal effect produced by the exposure of the whole body of an animal to roentgen rays formed the subject of some of the most painstaking and intriguing investigations. It was hoped that through such studies an exact knowledge might be gained as to the uppermost limit of the dose which could safely be tolerated in man and that by subdividing this dose proper values could be established which would lead to the slightest possible systemic reaction in the various therapeutic applications.

The series of these investigations was started in 1904 by Heineke (1), who subjected the entire bodies of mice and guinea-pigs to the effect of rather superficial roentgen rays, the most penetrating that could be obtained with the type of apparatus available at that time. Heineke found that, if large doses were administered, a complete destruction of the lymphatic system developed within twenty-four hours, with subsequent death of the animal. If the dose was smaller, so that the animal did not die, the lymphocytes reappeared in the blood and in a short period they completely regenerated.

Following the initial work of Heineke, other valuable contributions appeared, so that soon a rather significant literature accumulated dealing with various aspects of the problem. The experimental results obtained, however, continued to remain indefinite and often contradictory, due on one side to the lack of constancy of output of apparatus used and on the other to the inaccuracy of the measuring devices. A duplication of the experiments at various sources could be accomplished only with difficulty and at great cost of time.

In the light of newer technical developments, the subject has been retaken during the last few years by several eminent investigators and, fortunately, progress has been much swifter.

Ellinger (2) in 1940, as a preliminary step, studied under well defined and very precise experimental conditions the effect of increasing doses of roentgen rays on the common goldfish (*Carassius auratus*). He found that no changes occurred, as a rule, during the first week following irradiation. In the second or third week the fish became less active, stopped eating, became dyspneic, and eventually died. A dose of 1,500 r of roentgen rays of H.V.L. 0.233 mm. Cu killed all goldfish within nineteen days. If a mortality curve was plotted for the various doses up to that point, this assumed an S shape, similar to that observed in experiments with single cells. All these phenomena occurred with such regularity that Ellinger felt justified in proposing the introduction of goldfish as a biologic test object of the roentgen-ray effect.

In the present issue of RADIOLOGY, Ellinger (3) publishes the results of his experiments with lethal doses of roentgen rays on white laboratory mice and guinea-pigs. To facilitate grading of the effect of the roentgen rays from a more practical standpoint, he differentiates between a *minimum lethal dose*, an amount of radiation producing at least 10 per cent fatalities, an *average lethal dose*, producing 50 per cent fatalities, and an *absolute lethal dose*, producing death of all animals within a given period. It was found that for mice, with use of roentgen rays of H.V.L. 1.25 mm. Cu (200 kv.p., 0.13 mm.

Sn, 0.25 mm. Cu) and rice as backscatter medium, the minimum lethal dose amounted to 200 r in air and the absolute lethal dose to 1,000 r in air given in one seance. Here, too, there was a latent period, but of only two to five days' duration; then the mice showed shaggy fur, loss of appetite, and diarrhea. If the dose was between 200 and 600 r in air, the mice died as a result of these symptoms. When they survived, a return to normal occurred within fourteen to twenty days. If, however, the dose exceeded 1,000 r in air, some mice died on the second day without any prodromal symptoms and the remaining on the third or fourth day with somnolence, dyspnea, and diarrhea. As compared to fish, the life span was also shortened in all instances. According to Ellinger, this shortening of the latent period and life span following increasing doses of roentgen rays is a characteristic of the species and serves as a criterion of differentiation between mammals and fish. The mortality curve for mice followed the same S-shaped pattern as for single cells and fish.

In guinea-pigs, Ellinger noted under exactly identical experimental conditions that the percentage mortality increased progressively with increasing doses of roentgen rays in a manner similar to that of goldfish and mice, but the absolute lethal dose amounted to only 500 r in air. Another notable species difference was the double latent period in relation to mice. Even if a dose as high as 1,500 r in air was administered, the latent period remained six to eight days, while in mice, as already stated, it was two to five days. In this respect the double life span of guinea-pigs, as compared to mice, may have some significance. After the latent period, some guinea-pigs suddenly exhibited severe diarrhea and died within a few hours, the rest showed ragged fur, loss of appetite, and diarrhea and died during the subsequent days. In those which recovered, a restoration to normal occurred within twenty days. A plotting of the mortality curve revealed the same S-shaped pattern as in all former instances, but the slope appeared much steeper, a fact likewise attributed to the characteristics of the species.

A series of very valuable experiments, along similar lines, was carried out by Henshaw (4). After first studying the effect of single doses of 50 r applied to the whole body of C3H mice, Henshaw subjected to increasingly larger doses of roentgen rays, ranging from 50 to 400 r, the entire bodies of mice of two different strains (C3H and LAF_1) and guinea-pigs of a single strain. Rigorous technical procedures were observed. The roentgen rays employed were produced with 200 kv., 1 mm. Cu, and all doses were expressed in terms of equivalent air measurements. It was found that guinea-pigs were more susceptible to the irradiation than mice and that there was a difference of susceptibility even between the two strains of mice. Occasionally a guinea-pig died within seven to ten days after a single dose of only 100 r. More than half were killed by doses of 200 r and none survived 400 r. C3H mice were rarely killed by doses of 300 r, 20 to 40 per cent were killed by 400 r, and all were killed by 600 r. All LAF_1 mice survived doses of 400 r, their absolute lethal dose being probably around 600 r. Thus, while there is some difference in the magnitude of the absolute lethal dose in the experiments of Ellinger and Henshaw, a fact which may be attributable to the different types of experimental set-up, in the main the dependence of the lethal effect of roentgen rays on the species specificity seems to be proved beyond doubt.

A closer analysis of the immediate cause of death under the above-mentioned experimental conditions shows that the chief factors responsible are the complete depletion of the hematopoietic system and the irreparable damage done to certain tissues. The variation in the radiosensitivity of the cellular elements and structural components of the body received from the earliest days considerable attention, and through study of the effects of

local or regional roentgen exposures laws have been established which now must be considered fundamental. When the whole body is irradiated, the same laws apply, but here the capacity and extent of recovery of the destroyed tissues also play a paramount role. If a certain vital organ has been irreparably damaged or a certain system irrevocably annihilated, death follows without fail. In general, the younger and more immature a cell or structure, the more apt it is to be destroyed by a smaller dose of roentgen rays. On the other hand, the larger the dose of the roentgen rays administered, the more organs and systems are likely to be put out of function. Ellinger, through a systematic postmortem examination of the killed animals found that the complete destruction of the malpighian bodies of the spleen represented the climax of irreversible damage. Henshaw, who performed very exhaustive hematologic studies as well as numerous histopathologic examinations of the lymphoid organs, bone marrow, and testes, noted that, in a general way, the tissue response consisted of a parenchymatous cell loss. If the damage was not too severe, a slow recovery followed. Regeneration in each case started from primitive cell forms that had survived irradiation fatal to other cells. Leukocyte reserves, especially when the doses were small, prevented the peripheral blood picture from reflecting precisely the condition of the hematopoietic system. If too large a number of the primitive cells were destroyed, recovery of the system became impossible and the animals died. It is interesting that for equal doses, decreasing amounts of tissue damage were seen in guinea-pigs, C3H mice, and LAF_1 mice, in the order given, that is in exactly the same order in which the lethal doses for the respective animals had increased. This variation in injury and recovery of the tissues of the different animals, and even strains of the same animal, accounts for the species specificity if the irradiation is carried out with doses corresponding to the known lethal doses or thereabouts.

An entirely different situation arises, however, when the roentgen exposure of the whole bodies of animals is undertaken with massive doses, representing many times the known lethal dose. Henshaw (5) irradiated C3H mice, guinea-pigs, and rabbits with 25,000 to 50,000 r (200 kv., no filter, 250 r per minute in air, at 50 cm. distance) and found that all animals died within a few hours, some during the actual process of exposure. After irradiation had been in progress about an hour, the animals became restless and breathing was labored; then they showed progressive cyanosis, hyperthermia, and intermittent spastic twitchings. During the last ninety minutes they exhibited periods of alternating stupor and hyperactivity. Strong stimuli would set off sudden, uncoordinated movements. Finally death occurred with the animals lying on their sides in a state of complete spasm. The guinea-pigs as a rule were dead at the end of a three-hour exposure, rabbits within three to six hours after exposure, and the mice within ten to forty-eight hours. Clearly the similar response in all three types of animals to massive irradiation eliminates species specificity. Immediate postmortem examinations revealed extensive degenerative changes of the nuclei and cytoplasm in practically every tissue of all animals, suggesting violent cytolysis irrespective of the species. It is assumed that the sudden release of enormous toxic products evoked a general systemic reaction which completely overshadowed the much slower effect of the functional cell loss.

In this manner, death due to massive irradiation of the entire body is caused by a form of shock. According to Henshaw, the lack of hemoconcentration and the suddenness of death in the acute cases set this type of shock completely apart from that seen in trauma, burns, and various other injuries.

Obviously, further elaborate studies are necessary before the problem is elucidated. With the newer developments of megavoltage roentgen therapy and the continuous

extension of the clinical use of artificial radioactive substances, such studies will acquire more than academic interest.

T. LEUCUTIA, M.D.

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The Associate Editorship

For some time the Editor has felt the need of the advice and help of an Associate Editor who would be particularly concerned with the problems of radiotherapy, as Doctor Camp, the present Associate Editor, is with diagnosis. The Publication Committee, realizing the complexities of modern radiology, has appreciated the wisdom of such an addition to the Editorial Staff and accordingly requested Dr. Hugh F. Hare of Boston, Mass., to act in that capacity. It is with great pleasure and satisfaction that we record his acceptance of this post.

Doctor Hare received his training in radiology under Dr. Merrill Sosman at the Peter Bent Brigham Hospital and is now associated with the Lahey Clinic as head of the radiological department. He has made important contributions to the radiological literature, all showing a strong clinical background.

ANNOUNCEMENTS AND BOOK REVIEWS

SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

Preliminary announcements have been received of the Second Inter-American Congress of Radiology to be held in Habana, Cuba, Jan. 19–24, 1946, under the presidency of Dr. Pedro L. Fariñas, and a cordial invitation to attend has been extended to the membership of the Radiological Society of North America. The program of the Congress will include four official lectures, scientific sessions, and an extensive scientific exhibit. The formal organization of the Inter-American College of Radiology is scheduled for this meeting.

It is hoped that there may be a large North American delegation present at this Congress and that it may be truly representative of radiology in the Americas. Inquiries for further information should be addressed to the Secretary-General, Dr. R. Hernandez Beguerie, Calle 23 No. 411, Vedado, Habana, Cuba.

OVERSEAS LECTURES ON BONE AND JOINT RADIOLOGY

Dr. James F. Brailsford of Birmingham, England, having been invited on various occasions to lecture before men of the Medical Services in the U. S. Army stationed in Great Britain, has arranged to present a course of eight or twelve lectures on the various aspects of bone and joint disease, either at one of the hospitals or at the University of Birmingham. "This," he writes, "I do as a small mark of personal appreciation of the help you are giving to us."

RADIOLOGY is glad to make an announcement of this exceptional opportunity for radiologists in the Armed Services now in England and to suggest that those desiring more specific details communicate with Doctor Brailsford, 20, Highfield Road, Edgbaston, Birmingham, 15.

CANCER TEACHING DAY SARATOGA SPRINGS, N. Y.

Cancer Teaching Day was observed in Saratoga Springs, N. Y., on Jan. 18, under the auspices of the state and county medical societies and the Division of Cancer Control of the New York State Department of Health. The speakers were Dr. Andrew H. Dowdy on "Epithelioma of the Skin," Dr. Gray H. Twombly on "Cancer of the Cervix," Dr. Lloyd F. Craver on "The Significance of Enlarged Lymph Nodes," and Dr. Frank E. Adair on "Diagnosis, Treatment, and Results in Cancer of the Breast."

In Memoriam

JOHN H. GEMMELL, M.D.

1904–1944

Dr. John H. Gemmell died suddenly on Dec. 2, 1944, in Philadelphia at the age of forty.

Doctor Gemmell was born in Brainerd, Minn. Following his premedical training at Carleton College, he received the degree of M.A. in Physiology from the University of Minnesota in 1926, and of M.D. from the University of Minnesota in 1927. The high quality of his undergraduate work is attested to by his membership in the society of Sigma Xi. He served his internship in the Vancouver Hospital in Vancouver, British Columbia, after which he was resident in radiology in Bellevue Hospital, New York City. He became a diplomate of the American Board of Radiology in 1936.

Doctor Gemmell practised his specialty in Phillipsburg, Penna., in 1930–35, and in Rochester, Penna., in 1935–42. In 1942 he became associated with Doctor W. Edward Chamberlain in the Department of Radiology of Temple University Medical School and Hospital, Philadelphia. On the day of his death he seemed in perfect health and in unusually good spirits, having just returned from a vacation with his wife and daughter.

Doctor Gemmell had many close friends both in and out of organized Radiology. He was widely known for his sound ideas on the problems of medical economics and hospital-radiologist relationships. He was a member of the Radiological Society of North America, the American College of Radiology, and the Pennsylvania Radiological Society. For many years he was Counselor for the State of Pennsylvania, American College of Radiology, and Chairman of the Economics Committee of the Pennsylvania Radiological Society. In 1941 he served as President of the Pittsburgh Roentgen Society. He was elected President of the Pennsylvania Radiological Society in 1943.

W. EDWARD CHAMBERLAIN, M.D.

WILLIAM W. BOWEN, M.D.

1869–1944

Dr. William W. Bowen, a charter member of the Western Roentgen Society, and a member of the Radiological Society of North America until he retired from active practice in 1938 because of ill health, died at his home in Fort Dodge, Iowa, on Dec. 20, 1944, at the age of seventy-five. He was one of the organizers, in 1914, of the Iowa Roentgen Society, which later became the Iowa X-Ray Club. He was President of the Iowa State Medical Society in 1933.

JOHN H. GEMMELL, M.D.
1904–1944

OSCAR ROBERT R. TROJE, M.D.

Dr. Oscar Robert R. Troje, for many years chief radiologist at the Employees' Hospital of the Tennessee Coal, Iron and Railroad Co., Fairfield, Ala., died on Dec. 12, 1944, at the age of fifty-nine. Doctor Troje was graduated from the University of Kansas School of Medicine in 1907. He was a diplomate of the American Board of Radiology and a member of the American College of Radiology, American Roentgen Ray Society, and the Radiological Society of North America. He held the rank of Lieutenant Commander in the U. S. Naval Reserve, not on active duty.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

MEDICAL USES OF SOAP. A SYMPOSIUM. By G. THOMAS HALBERSTADT, B.S.CH.E., MARION B. SULZBERGER, M.D., THEODORE CORNBLEET, M.D., LESTER HOLLANDER, M.D., C. GUY LANE, M.D., DANIEL J. KOOYMAN, PH.D., RUDOLF L. BAER, M.D., CAREY MCCORD, M.D., MORRIS FISHBEIN, M.D., AND IRVIN H. BLANK, PH.D. Edited by MORRIS FISHBEIN, M.D. A volume of 182 pages, with 41 illustrations. Published by J. B. Lippincott Co., Philadelphia. Price $3.00.

Book Reviews

TECHNIC OF ELECTROTHERAPY. By STAFFORD L. OSBORNE, M.S., PH.D., Assistant Professor, Department of Physical Therapy, Northwestern University Medical School, and HAROLD J. HOLMQUEST, B.S., B.S. (M.E.), Lecturer in Applied Physics, Department of Physical Therapy, Northwestern University Medical School, Chicago, Ill. A volume of 760 pages, 293 illustrations, 72 tables. Published by Charles C Thomas, Springfield, Ill., 1944. Price $7.50.

This text was written primarily for the medical and the physical therapy student, physical therapy technician, and practising physician. According to the authors' statement in the preface, the material presented is that used during the last sixteen years in teaching electrotherapy at Northwestern University.

The book is somewhat unusual in that the authors are highly trained, respectively, in what might be regarded as quite diverse fields, namely in physiology and in physics and electrical engineering.

The attempt is made to present basic information concerning electrophysics and physiologic effects of electrotherapy. The subject matter is divided into several sections, as follows: (1) direct current, (2) electrical muscle stimulation, (3) radiation, (4) high-frequency current. In general, each electrical agent is discussed from the standpoint of basic physics, physiology, types of apparatus, and technic of application. Specifically, the section on radiation is devoted to thermogenic agents or heat-producing radiation and ultraviolet light, and the section on high-frequency current includes the technic of administering artificial fever, its uses, and its physiologic effects.

The authors have endeavored to present their material in a manner which would make it useful both to the person who has little basic knowledge, particularly of physics, and also to the highly trained person. The fundamentals of physics are presented in the context, and the more complex physical and mathematical problems are discussed in detailed footnotes, intended to meet the needs of the person who has had considerable education in the field of electrophysics.

In some instances, there is justification for disagreement with the prescriptions for electrotherapy recommended by the authors. No attempt has been made to present specific indications for use of the various types of electrotherapy. This omission may be explained on the basis of the fact that neither author is a physician. Since most of the apparatus shown in the photographs throughout the book are made by one manufacturer, the authors may be criticized unjustly as having been commercially influenced. The contents of the book otherwise do not confirm this supposition. The authors apparently are definitely partial to one procedure in the production of artificial fever by physical means and appear to lack experience with other types of apparatus.

The book is well written, clearly arranged, and adequately documented, and includes a review of most of the recent important experimental work in electrotherapy. It meets a definite need and undoubtedly is the most exhaustive scientific treatise on this particular subject. It is recommended to physicians specializing in physical medicine and to teachers of technical and medical students as essential reading, and to practising physicians and physical therapy technicians as a valuable reference work.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer Charles M. Gray, 306 Citizens Bldg., Tampa 2.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary-Treasurer,* George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.,—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

Rochester Roentgen-ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

The Philadelphia Roentgen Ray Society.—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota South Dakota, Nebraska, Kansas, Texas, Wyoming Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St. Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave. Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Intracranial Aneurysm: Diagnosis and Treatment of Aneurysm of the Internal Carotid Artery. James L. Poppen, Hugh F. Hare, and Daniel Weller. S. Clin. North America **24:** 700–709, June 1944.

The usual signs and symptoms of intracranial aneurysm are periodic headaches (usually on the side of the lesion), pain in or about the eye, trigeminal neuralgia in one or all the branches, unilateral impaired vision, optic atrophy, defects in the field of vision, and evidence of subarachnoid bleeding, such as stiff neck, dizziness, fainting, coma, or convulsions. While the onset of these symptoms is usually sudden, it may be insidious. Either impaired vision or extraocular muscle weakness may be the initial symptom. Although this clinical syndrome is almost pathognomonic of aneurysm of the internal carotid artery or the circle of Willis, verification of the diagnosis requires roentgen examination, pneumoencephalography and arteriography, or exploration.

In order to demonstrate small lesions in or about the sella turcica, properly exposed, well developed stereoscopic films of the cranial vault in the exact lateral position are necessary. Both the anterior and posterior clinoids must be shown in a lateral view, and the tips of these processes in anteroposterior and postero-anterior projections. Calcified aneurysms may be seen directly. If calcification is absent, then erosion, sharpening, or elevation of the clinoid processes is significant. Often one may see a unilateral erosion of the lateral wall and floor of the sella turcica, enlargement of an optic foramen, particularly when the aneurysm is in a cavernous sinus, or thinning and erosion of the sphenoidal ridge. Secondary changes in the sella turcica or dorsum sellae may result from internal hydrocephalus caused by blocking of the subarachnoid spaces with blood following rupture and subsequent interference with cerebrospinal fluid circulation, or from direct blockage of ventricular drainage by the aneurysm if the latter is of sufficient size.

Ventriculograms and encephalograms are usually normal in the presence of small lesions. The lesions may attain such size, however, as to distort or produce filling defects in the anterior and temporal horns of the lateral ventricle, the third ventricle, and the basal subarachnoid spaces.

Arteriography is unquestionably the most accurate means of diagnosis. Treatment can be carried out as soon as the diagnosis is established, without subjecting the patient to another operative procedure. Exposure of the carotid arteries is carried out under sterile conditions. Satisfactory films may be obtained by the direct injection of 4 to 8 c.c. of thorotrast into the internal carotid artery, so timed that exposure is simultaneous with the injection of the last 2 c.c. of fluid. Single or stereoscopic lateral films are taken with the patient in the supine position. Tolerance for complete occlusion of the internal carotid artery can be determined while waiting for the development of the roentgenograms. If these are suitable, aneurysmal dilatation, if present, can be readily identified.

The etiologic factors involved in the production of intracranial aneurysms, as well as their pathologic nature, clearly indicate that the only logical therapeutic approach is early surgical intervention. Many cases lend themselves well to such treatment. The outlook becomes more serious in the untreated cases because of the irreversibility of the pathologic process and the imminent danger of rupture. For that reason, early diagnosis and treatment are essential. Thirty cases of intracranial aneurysm have been treated surgically at the Lahey Clinic; four of these are reported in detail, with reproduction of the arteriograms.

Osteomyelitis of the Frontal Bone. Lester A. Brown. Arch. Otolaryng. **39:** 485–491, June 1944.

A résumé of 10 cases of osteomyelitis of the frontal bone, in which were found most of the usual complications of this disease, is presented.

Headache is the most frequent complaint, varying in intensity from mild discomfort to excruciating pain. The temperature is commonly elevated. As the disease progresses and complications develop, the headache may become intolerable and one or more of the following signs and symptoms may appear: subperiosteal fluctuation, varied degrees of nuchal rigidity, mild delirium, choked disks, semicoma or even complete coma. Occasionally sudden death ensues.

The most suspicious finding is a doughy subperiosteal swelling of the forehead on one or both sides, extending from the brow toward the hair line, the height of the swelling being directly proportional to the osseous involvement. There is tenderness over the involved sinus or over the entire forehead. Intranasal inspection generally reveals pus escaping from the anterior end of the middle meatus on the affected side.

Although roentgen evidence of osteomyelitis is manifest only after the infection has involved the bone for several days, roentgenography is nevertheless a worth-while and at times a decisive factor. The lateral aspect is of little importance; a view in the nose-forehead position and stereoscopic films in the nose-chin position may provide the necessary information. The characteristic roentgen sign is decalcification, early evident at the junction of the anterior and posterior bony plates of the frontal sinus, that is, at its superior limit. This "white line" becomes less distinct and finally fades out, in contrast to the "white line" of the opposite frontal sinus. On the other hand, roentgen studies may indicate frontal sinusitis of the unaffected side and normal appearance of the affected side. This happened twice in this series. The cause of the miscalculation of the roentgenographic evidence was a diffuse decalcification of both anterior and posterior bony plates of the affected sinus to such an extent that by comparison the normally calcified bone of the unaffected sinus looked dense. When the "white line" disappears, beginning decalcification of the frontal bone outside the region of the frontal sinus will be noted. No longer can effective medical treatment be continued, and the occasion for surgical intervention is at hand.

In this series of 10 cases of frontal bone osteomyelitis, complications were present as follows: epidural abscess and abscess of the brain in 4 cases; epidural abscess alone in 3; subdural abscess in 2; subperiosteal abscess in 1. Meningitis was a prominent factor in only 3 instances.

Treatment resolves itself into (1) the attempt to remove the area of infection with a surrounding area of good bone, (2) the attempt to prevent the spread of the osteomyelitis to supposedly uninfected bone, and (3) the management of complications.

Prior to operation the roentgenograms are studied so that the amount of bone involved may be determined. The diseased area, with a surrounding healthy zone, is removed in one piece, and its edges, as well as the edges of the remaining bone, are inspected for infected areas. The operative specimen is immediately sent to the x-ray room for a roentgenogram, which may aid in determining whether the infection is all included. When it is thought that all diseased bone has been removed, the operative field is lightly covered with a powdered sulfonamide compound. The incisions are left open. The use of vitallium skull plate promises to be the method of choice for the repair of the deformity caused by the osteotomy.

There were 2 deaths in the author's series, both in cases complicated by massive subdural abscess. These cases are summarized.

THE CHEST

Accidentally Discovered Pulmonary Tuberculosis. Hans Abeles and Max Pinner. Am. Rev. Tuberc. **49:** 490–500, June 1944.

With the widespread use of mass x-ray surveys of the chest among apparently healthy persons, evidences of pulmonary tuberculosis are discovered in many who are without symptoms of disease that might induce them to seek medical advice. In a considerable percentage of these, the diagnosis of the activity of the process is neither readily made nor excluded. During the past few years the authors have observed 91 patients whose tuberculosis was discovered accidentally. These patients were observed in a routine way, with emphasis on all those observations which seem likely to answer the question "active or non-active?"

An analysis of the results of this study shows that there are three criteria for activity which have a high degree of reliability: (1) radiographic instability, (2) properly related symptoms, (3) bacterial findings. In contrast to these, the sedimentation rate failed in about 40 per cent to determine the status of the disease, and leukocytosis and physical examination correctly suggested activity in less than half of the active cases. It is emphasized that negative bacteriological findings are significant only if based on numerically sufficient and technically adequate examinations. Thus, 24 of 77 positive findings were obtained only by culture and frequently not by the first culture made; 28 of the positive findings depended upon examination of gastric content. Even in minimally active cases, bacilli were found in nearly 80 per cent.

With regard to significance of symptoms, not all of these patients are asymptomatic, even though the disease was discovered during a mass survey. Careful questioning, not only at the time the lesion is discovered, but subsequently, after mental resistance against acceptance of the diagnosis has been lessened, will determine to a large degree how many of these patients are really asymptomatic. In the present series there were only 16 among 86 patients with active disease who never experienced any symptoms.

L. W. PAUL, M.D.

Problem of Tuberculosis in Apparently Healthy Man as Shown in the Routine Examinations for Induction into the Armed Forces. C. Howard Marcy. Dis. of Chest **10:** 241–245, May-June 1944.

The author stresses the magnitude of the tuberculosis problem, pointing out that approximately 1.9 per cent of all men passing through the Induction Boards are rejected for military service because of this disease. In Pennsylvania alone the number has exceeded 15,000.

From a medical standpoint the rejectees are divided into three groups: (1) those with minimal healed lesions; (2) those with demonstrable disease of undetermined stability; (3) those with unquestionably active disease. Men in the first group can in many instances return to their former civilian occupations with safety, but they should receive advice as to the significance of their condition, with a view to dispelling unfounded fears. The second group requires thorough study, sound medical advice, and prolonged follow-up, while the third group demands hospitalization.

The responsibility for the care of these tuberculous rejectees rests with the medical profession. It must take an intelligent interest in the problem if the effective case-finding program established in the Armed Forces is not to lose its value for the prevention and control of tuberculosis in the civilian population.

HENRY K. TAYLOR, M.D.

Occurrence of Pulmonary Tuberculosis in Supposedly Screened Selectees. Arden Freer. Dis. of Chest **10:** 197–207, May-June 1944.

The object of the Army Regulations in regard to tuberculosis is to screen out of the service men with active and potentially active lesions which would interfere with the effective performance of their duties or later become a cause of disability. The present Regulations specifically exclude from military service not only those with any type of tuberculosis believed to be active, but also those with scarred infiltrative lesions exceeding a total area of 5 sq. cm. as seen in conventional flat films. Those with arrested lesions measuring less than 5 sq. cm. may be accepted for service if stability of the lesion has been demonstrated by at least six months' observation. Those with small calcified primary complexes are accepted without question, while acceptance or rejection of those with large or multiple foci is dependent upon the judgment of the medical examiner.

Early published and unpublished statistics from authoritative sources show a rejection rate of something over 1 per cent for pulmonary tuberculosis. Not only has x-ray examination been effective in screening out these cases, but it has been of value also in discovering significant non-tuberculous disease.

The efficiency of the procedure for screening out tuberculosis, in spite of the large number of cases detected, has been far from perfect. It was estimated from the re-examination of more than 53,000 films representative of a considerable number of induction stations that approximately 1,500 cases per million men were being missed. An analysis of admissions to the Fitzsimons General Hospital is also indicative of the failure of the induction examination to eliminate all cases. Missed diagnoses are attributed to inexperience, speed, fatigue, monotony, and clerical errors.

But while some cases of tuberculosis have escaped

discovery prior to induction, symptoms or subsequent routine Army examinations have resulted in discovery of the majority of these cases before great advance has occurred. A recent survey indicated that approximately 30 per cent were detected within a month and nearly 80 per cent within six months. Furthermore, routine chest films are required on discharge from the Army, and it may be reasonably expected that this will lead to the discovery of the vast majority of cases previously missed or developing during military service.

"More than 10 per cent of the total population of the country will have been x-rayed in the physical examinations incident to military service. Approximately 150,000 men will have been rejected for tuberculosis. Thousands of these open cases will undergo treatment with resultant arrest of a great number and prevention of further spread of the disease."

HENRY K. TAYLOR, M.D.

Studies of Rejectees for Thoracic Abnormalities. Wm. A. Hudson and David S. Brachman. Dis. of Chest **10:** 234–240, May-June 1944.

Between March 28, 1942, and June 30, 1943, 1,109 "chest rejectees" from the Wayne County (Michigan) Selective Service Draft Board, were examined for thoracic abnormalities. Of this group, 139 (12.4 per cent) gave a history of previous treatment for tuberculosis; hospitalization was recommended for 114 (10.3 per cent); 93 (8.4 per cent) were found to be normal. The number with reinfection tuberculosis was 787. Six hundred and nine cases of this group were classified as inactive, and in many of these a change of occupation was recommended to prevent future reactivation.

An interesting feature of this study is a comparison of the reinfection tuberculosis findings among the rejected men with observations on a group of 34 senior high-school students with tuberculosis, 21 cases from a housing project for homeless, unemployed men, and 147 cases discovered by the "usual means" (examination of patients with suggestive symptoms and of contacts) by the Detroit Department of Health. The figures for the rejectees showed 61 per cent minimal, 31 per cent moderately advanced, and 8.0 per cent far advanced lesions. Among the high-school students, 82.4 per cent had minimal and 17.6 per cent moderately advanced disease. The percentage of minimal lesions for the unemployed men was 52.4 per cent, and for those discovered by the "usual means" only 19.1 per cent.

A consideration of these figures, more particularly those for the rejectees and students, with their comparatively high percentages of minimal lesions, and the "usual means" group, with its low percentage, lends new emphasis to the value of mass surveys.

HENRY K. TAYLOR, M.D.

Tuberculosis as a Navy Problem. Dean F. Smiley and Herbert A. Raskin. Dis. of Chest **10:** 210–233, May-June 1944.

A statistical historical presentation is given of the progress of the battle against tuberculosis in the U. S. Navy. Included are 13 tables and 8 graphs showing the advances made, more especially since 1926. During the past forty-three years there has been a gradual reduction in the rate for "original admissions" to the sick list for tuberculosis, until in 1942 the rate was one-tenth of that for 1900. A sudden rise in admission rates and invalidings from the Service at the beginning of the present war is directly attributable to chronic arrested disease discovered through the greatly expanded utilization of roentgen examination of Navy personnel. The incidence of tuberculosis is about the same in the forces afloat as in the forces ashore From an occupational standpoint, the culinary, hospital corps, and engine groups showed a higher incidence than others.

A real advance toward eliminating tuberculosis from the Naval Service was made with the inauguration of roentgen examinations of the chest as a prerequisite to entrance into the Navy. To the present program of preinduction chest radiography and radiographic examination upon the advent of clinical symptoms, the authors would add (*a*) periodic chest radiographic studies of all hands at intervals graded to the risk of exposure and the severity of the duty, supplemented by clinical studies including tuberculin testing when indicated; (*b*) special studies of the factors operative upon the hospital corps, culinary and engine room groups which might conduce to tuberculosis; (*c*) an increased appreciation on the part of all Navy medical officers of the importance of the chest roentgenogram in the prompt establishment of a diagnosis of pulmonary tuberculosis.

"Given these additions, it would appear that the U. S. Navy, in the not too distant future, may fully realize the attainment of its goal—utter annihilation of tuberculosis." HENRY K. TAYLOR, M.D.

Pulmonary Tuberculosis in Navy Recruits. Robert Shapiro. Am. Rev. Tuberc. **49:** 485–489, June 1944.

Chest examinations of Navy recruits have been done by the photofluorographic method. This procedure was chosen because of its rapidity, its inexpensiveness, and the ease and simplicity of filing the films. The present report analyzes briefly the results in 50,100 consecutive examinations. Calcified lesions in the lung parenchyma, the hilar lymph nodes, or in both locations, were found in 10.7 per cent of the men examined. Of the 5,323 recruits with such evidence of calcified primary tuberculosis, 25 or 0.47 per cent were rejected because of the large number or massive size of the calcifications.

Of the total number of recruits examined, 420 (0.86 per cent) showed evidence of a reinfection type of pulmonary tuberculosis. No attempt was made to differentiate radiologically between active and healed tuberculous lesions in this category, but in 19 cases there was frank cavitation. All of the examinations on which this report was based were performed on men seeking admission to the Naval Construction Battalions, popularly known as the Seabees. A fair proportion of the men, therefore, were in the fourth and fifth decades of life, and in this respect they differed somewhat from the average Navy recruit, who is more likely to be in the second or third decade. The lesions which are considered as sufficient cause for disqualification are as follows:

1. Any evidence of reinfection (adult) type of tuberculosis, active or inactive, exclusive of slight thickening of the apical pleura.
2. Evidence of active primary (childhood) type of tuberculosis.
3. Inactive primary pulmonary tuberculosis, if the degree or extent of involvement appears to be of present or future clinical significance.

4. Extensive multiple calcification in the lung parenchyma and massive hilar calcification.
5. Evidence of fibrinous or serofibrinous pleuritis.

L. W. PAUL, M.D.

Tuberculosis Among Hospital Personnel. William G. Childress. Am. Rev. Tuberc. **49:** 501–509, June 1944.

Routine periodic chest x-ray examination of all employees in the Tuberculosis Division of Grasslands Hospital, New York was begun in 1932. In 1938 this type of examination was extended to employees throughout the general hospital. Grasslands is an 800-bed general hospital, with 300 beds for tuberculous patients housed in separate buildings. For the present study, work histories of 5,039 patients were obtained; of these, 3,700 had received one or more roentgen examinations of the chest; 2,092 were known to have been exposed to tuberculosis in the course of duty, while 2,947 were not exposed to known sources except as might be expected in a general hospital service.

Of the total number of persons examined, 45 who were originally symptom-free, with normal roentgenograms of the chest, were subsequently found to have tuberculosis; 39 of these were among those exposed to known sources of infection, while 6 had not been so exposed. In addition to this group, there were 14 employees in whom active lesions were found at the original x-ray examination; 57 per cent of these had been exposed for an average of 4.9 months prior to the examination and 43 per cent had not been exposed. There was another group of 88 persons in whom latent lesions were discovered on the first examination or on follow-up studies. A final group of 65 employees gave a previous history of tuberculosis; 51 of these were exposed to tuberculosis during employment, and in 14 (27 per cent) the lesions were reactivated; 14 were not exposed, and in 3 (21 per cent) of these there was reactivation.

Combining all of the groups, it is seen that a higher morbidity occurred among those exposed than among those who were not exposed. Of particular importance were the 45 symptom-free, roentgenologically negative patients in whom tuberculosis subsequently developed. In this group the morbidity was approximately seven times as great in the exposed as in the unexposed, and this incidence was higher regardless of age.

In an attempt to detect undiscovered tuberculosis among patients, routine fluoroscopic and chest x-ray examinations of 7,187 persons admitted to the hospital or its out-patient department were made from July 1, 1941, to Jan. 1, 1943. Of these, 201 (2.8 per cent) had evidence of reinfection tuberculosis, and of this number 42 (0.6 per cent) had active disease or x-ray lesions where activity could not be excluded.

The results of this study indicate that tuberculosis control programs should be designed to discover active tuberculosis in hospital personnel and also in hospital patients, so that active cases may be isolated and treated and protection given to those not already infected.

L. W. PAUL, M.D.

Importance of Bronchography in Cases of Unresolved Pneumonia. George S. Grier, III. Arch. Int. Med. **73:** 444–448, June 1944.

Routine roentgenography of the chest has kept most men with pulmonary tuberculosis from being inducted into the Army; but normal roentgenograms of the chest do not exclude bronchiectasis, and many cases of this condition are not detected. The authors seek not only to point out the importance of bronchography in cases of unresolved pneumonia, but also to show that frequently pneumonitis secondary to bronchiectasis is misdiagnosed as primary atypical pneumonia.

Forty patients with bronchiectasis, with an average age of twenty-six and one-half years, were admitted to the Station Hospital at Fort Eustis, Va., during a period of fifteen months. Nine of these patients were referred to the chest clinic because of a history of chronic cough, hemoptysis, or recurrent chest colds, while the remaining 31 (77.5 per cent) were admitted to the hospital with an initial diagnosis of primary atypical pneumonia.

The symptoms on admission, in order of frequency, were cough, mucopurulent sputum with occasional blood streaking, substernal soreness, chills, fever, and sweats. Examination showed slight impairment of resonance, suppressed breath sounds and fine, crackling, and coarse râles in the lower lobe of one or both lungs. A leukocytosis was present, with little increase in polymorphonuclear neutrophils. X-ray examination demonstrated stringy and mottled densities in the lower lobes of the lungs, usually unilateral and radiating out from the hilum toward the diaphragm. Lateral roentgenograms of the chest frequently revealed a pneumonic process behind the diaphragm or a cardiac shadow which could not be seen in the posterior-anterior view.

Bronchographic studies were done in cases in which resolution failed to occur in four to six weeks, and iodized poppyseed oil was injected into both sides even when the pneumonic process was unilateral. (Studies with iodized oil are contraindicated during acute pneumonitis, since this procedure may produce an exacerbation of the acute process.)

The technic of bronchography is given. In 30 cases the distribution of the bronchiectasis was found to be unilateral; in 20 cases it involved the lower lobe of the left lung. Tubular (19 cases) and fusiform (15 cases) dilatations were the most frequent types of bronchiectasis demonstrated; the saccular form (6 cases) was seen rather infrequently. Nine patients in this series showed extensive bronchiectasis, 20 moderately severe, and 7 mild; only 4 had localized disease.

The author concludes that bronchographic studies should be done in all cases of pneumonia which fail to resolve in a reasonable period (four to six weeks).

Primary Atypical Pneumonia, Etiology Unknown: Average Clinical Picture Based on Thirty-Seven Original Cases. Richard H. Smith. Ann. Int. Med. **20:** 890–902, June 1944.

The present study is based on 37 cases of atypical pneumonia seen between January 1941 and October 1942. The disease is referred to in this paper as "primary, atypical pneumonia, etiology unknown," which is the designation assigned by the Commission on Pneumonia of the U. S. Army. Among other designations in the literature are "virus pneumonia, type A," "acute pneumonitis," "acute respiratory tract infection, type A," "acute interstitial pneumonitis," "bronchopneumonia of unknown etiology, variety X," "current bronchopneumonia of unusual character and undetermined etiology," "virus-type pneumonia," "viral pneumonia," and many others. The causative organism has not been identified. Attempts to demon-

strate known Rickettsias and viruses have given negative results.

The pathological picture is that of a patchy, hemorrhagic, interstitial bronchopneumonia associated with acute bronchitis and bronchiolitis. The alveolar exudate contains chiefly mononuclear cells and may be hemorrhagic or organized. The alveolar walls are often thickened and infiltrated with mononuclears.

Little is known as to economic or occupational incidence, although institutional epidemics are common. Outbreaks have been reported in nearly every season and climate, both with and without coincident epidemics of colds.

On the basis of the calculated average findings in his 37 cases, the author presents a composite, hypothetical case history representative of the clinical picture.

The onset is practically never as severe as in lobar pneumonia. The highest temperature is usually noted on the first or second day in the hospital. The average maximum is 102 to 103° F. The mean duration of the fever is six days. The pulse rate usually corresponds to the temperature level. Paroxysmal cough was present in all but two cases of the recorded series. Sore throat, hoarseness, and severe headache were observed but not invariably.

The roentgenographic findings are not pathognomonic. The shadows are easily mistaken for tuberculosis or those of other types of pneumonia. Extremely dense shadows are rare. Hilar involvement, with radiating parenchymal lesions, is common. Any portion of the lungs may be involved. Shadows vary in size and differ in character from patchy to diffuse to mixed. Rarely does the density occupy an entire lobe. Often it involves portions of adjoining lobes. The extent of the lesion disclosed by the roentgenogram is greater than that anticipated on physical examination. The sputum is almost invariably mucopurulent. The average white blood cell count is 9,000; in no instance did it exceed 14,700. The differential count is often normal. Blood cultures are sterile.

Complications are unusual. Death occurs rarely, the reported mortality being 1 per cent.

The treatment is purely symptomatic. Bed rest is essential. Fluids should be forced. Codeine, throat irrigations, expectorants, and sedatives are welcome where indicated. Sulfonamide drugs are of no value.

STEPHEN N. TAGER, M.D.

Primary Atypical Pneumonia Simulating Infiltrative Pulmonary Tuberculosis. Alfred L. Kruger, Albert W. Wallace, John P. Medelman, and S. Butler Grimes. Dis. of Chest **10:** 171–179, May-June 1944.

Between March 1942 and November 1943 the authors observed 61 hospitalized patients with lesions in the upper lung fields, in whom the original roentgen findings simulated pulmonary tuberculosis. Eighteen other subjects, afebrile and asymptomatic, referred for routine roentgen examination of the chest showed similar upper lobe lesions. Serial roentgen studies revealed complete resolution of the lesions in all instances in seven to twenty-six days and established the diagnosis of atypical pneumonia.

The authors conclude from observations made in over 1,000 cases that there are no characteristic or pathognomonic roentgen findings in atypical pneumonia which permit differentiation, on a single examination, from an ordinary bronchopneumonia or tuberculous infiltration. They caution against a diagnosis of tuberculosis in upper lobe infiltrative lesions without serial roentgen studies and examination of the sputum for tubercle bacilli. Three case histories are included.

HENRY K. TAYLOR, M.D.

Elements of Diagnosis and Prognosis in Pneumoconiosis. Leroy U. Gardner. Rocky Mountain M. J. **41:** 385–391, June 1944.

The term pneumoconiosis means any state of the lungs resulting from prolonged inhalation of dust particles, rock and mineral dusts being the most common excitants. Colored dusts, such as the oxides of iron or coal, may be deposited in the framework of the lungs and produce pigmentations, sometimes referred to as siderosis or anthracosis, but these have no measurable effect on respiratory function. Combinations like anthracosilicosis and siderosilicosis are common, but the dangerous element is the silica and not the coal or iron. Irritants like quartz or other forms of free crystalline silica and asbestos provoke the formation of scar tissue which replaces functional lung and gives rise to pulmonary disease—silicosis and asbestosis.

In every pneumoconiosis there is some distortion of the normal roentgen pattern of the lungs, but such distortion does not necessarily signify impairment of function. Pulmonary infections occur in persons exposed to occupational dusts just as they do in the general population, but the discovery of roentgen evidence of the two conditions in the same lung constitutes no proof of a causal relationship. The latter must be determined statistically from experience in large groups exposed to particular kinds of dusts, perhaps with the aid of experimental observation. It is well established that free silica dust specifically predisposes to infection with the tubercle bacillus but not to infection with other bacteria. The same cannot be said of other forms of pneumoconiosis.

The diagnosis of pneumoconiosis depends upon three essential factors: history of exposure; characteristic roentgenogram; a physical examination often marked by findings that are trivial in comparison with the extent of abnormal x-ray shadows.

The x-ray manifestations are of four main patterns:

(1) *Simple Exaggeration of the Normal Linear Markings:* Most of the shadows cast by x-rays traversing a normal lung are due to vessels containing blood. The air-filled bronchial tree throws no shadow except in the case of the stem bronchi and trachea, whose thick walls are barely visualized in a good roentgenogram. Thickening of the pulmonary vessels will result in heavier vascular shadows. It so happens that most inhaled materials tend to accumulate first in the walls of the pulmonary vessels; this increases the density of the delicate connective tissue about the vessels, and heavier shadows are produced. There is nothing specific about this pattern to indicate its cause, and it is rarely associated with clinical symptoms.

(2) *Reticulation* is a term recently popularized in England as descriptive of the shadow pattern in the films of coal miners. Between the exaggerated linear shadows of thickened blood vessels is a background of small, ill-defined ringlets, which in the aggregate suggests the appearance of a rough orange peel. Apparently these shadows are cast by thickened septa between lobules of lung tissue. Like the outer coats of blood vessels, the coarser septa of the lung contain large lymphatic trunks and some kinds of dust particles tend to accumulate in these.

(3) *Nodulation:* Usually the nodules, not over 3 or 4 mm. in diameter, which constitute the characteristic tissue reaction of silicosis, are evenly distributed throughout all parts of both lungs. In long-standing cases, the costophrenic angles are often clear, due to the development of emphysema.

(4) *Massive Conglomerate Nodulation:* The writer subscribes to the South African view that the presence of large localized areas of conglomeration in a film showing nodulation constitutes evidence of associated infection, which so injures the lung that more silica is retained. Massive conglomerate lesions usually occur in the upper portions of the lungs; they may be bilaterally symmetrical; they may radiate outward from the hila. Sometimes they involve the lower lungs.

In addition to the four patterns mentioned above, the author describes a "*diffuse haze to ground glass appearance,*" which is most commonly associated with early asbestosis and with some other less known types of pneumoconiosis. In early cases such shadows spread over the lower lung fields to more or less obscure the normal markings. As the disease advances, the haze becomes more dense and extends upwards. In fully mature cases of asbestosis all vascular markings are obliterated in the lower two-thirds of the lung fields by a widespread uniform density composed of confluent minute stippled shadows.

Unilateral patterns are presumably not due to dust inhalation. It should always be kept in mind that a poor film, especially one taken short of full inspiration, produces artefacts that may be mistaken for evidence of pneumoconiosis.

Physical examination, which constitutes the third essential in the diagnosis of pneumoconiosis, includes the usual procedures plus a carefully given exercise tolerance test. In general, symptoms are most severe in the massive conglomerate form. Most of these patients are short of breath, some even at rest. The symptoms and signs are those of emphysema and chronic bronchitis.

Treatment is essentially prophylactic. Mention is made of the employment of aluminum dust inhalation as a preventive measure in workers exposed to silica dust. If enough aluminum is inhaled it will neutralize the quartz effects. While it will not cause preformed silicotic nodules to disappear, earlier tissue reactions may resolve. Aluminum inhalation should not, however, be allowed to replace good hygienic control.

PERCY J. DELANO, M.D.

Roentgenograms of the Chest Taken During Pertussis. Jerome L. Kohn, Irving Schwartz, Jerome Greenbaum, and Mary M. I. Daly. Am. J. Dis. Child. **67:** 463–468, June 1944.

A study was made in the Willard Parker Hospital (New York) of repeated roentgenograms of the chest in 222 cases of pertussis in children from the age of five months to eight years. These examinations were made fourteen to twenty-one days after the onset of symptoms and many showed evidence of peribronchial infiltration, pneumonic consolidation, and atelectasis.

The patients were divided into three groups: those with no fever, those with low-grade fever, and those with high fever. Normal roentgenograms were obtained in some patients of all three groups. The incidence of pulmonary abnormalities was much greater, however, in patients who had fever. The most frequent site of atelectasis and consolidation was the right middle lobe. The secretion in pertussis is known to be tenacious and viscous. The bronchus of the right middle lobe is smaller than those in the upper or lower lobes. The authors believe these conditions contribute to frequent atelectasis with secondary infection in this lobe. Roentgen evidence of enlarged tracheobronchial lymph nodes was infrequent, which was in keeping with autopsy findings. Physical findings were not so great as would be expected from the roentgen findings.

LESTER M. J. FREEDMAN, M.D.

Atelectasis Complicating Acute Poliomyelitis with Involvement of Respiratory Muscles. M. Cooperstock. Am. J. Dis. Child. **67:** 457–462, June 1944.

In paralysis of the respiratory muscles due to poliomyelitis, a number of factors predispose to the development of atelectasis with its accompanying danger of bronchopneumonia. Foremost among them is the reduction of vital capacity which results not only from respiratory muscle paralysis but from lack of general muscle tonus. The cough reflex is impaired in proportion to the involvement of the anterior horn. Adequate bronchial drainage is also interfered with by actual reduction in size and motility of the bronchi in a hypoventilated lung. The lower lobes may, in addition, be subject to compression from below by a paralyzed diaphragm. Atelectasis occurs when secretion plugs a bronchus, which in turn provides a fertile soil for the development of secondary pneumonia.

Four well illustrated cases are reported. Atelectasis occurred in these patients three weeks to one year after admission to the hospital, well after the acute stage of poliomyelitis had passed. Signs and symptoms of pneumonia developed after the atelectasis except in one instance where the infection was present two days prior to the pulmonary collapse. All patients were given sulfonamide therapy and were using the Drinker respirator. One patient died.

Avoidance of exposure to respiratory infection is an important prophylactic measure. Early administration of sulfa medication is urged at the first indication of pneumonia. The continued use of a mechanical respirator is advised, especially where there is disturbance of the cough reflex. The one death reported is attributed to the delay in instituting sulfa therapy and to interruption in the use of the Drinker apparatus. Early drainage by bronchoscopy is suggested and considered useful but was not employed in this series.

LESTER M. J. FREEDMAN, M.D.

Spontaneous Pneumothorax Complicating Bronchial Asthma. Report of Two Cases and Consideration of Possible Mechanisms Involved in Its Production. Mason Trowbridge, Jr. Arch. Int. Med. **73:** 460–465, June 1944.

Spontaneous pneumothorax as a complication of bronchial asthma occurs chiefly in young persons, of both sexes. The mode of onset is variable. Dyspnea is usually present and subjectively different from that ordinarily accompanying asthmatic attacks. Pain is an almost constant feature, but it may be absent, particularly in cases of recurrent pneumothorax. It is usually pleural and may radiate to the flank; a sense of constriction in the chest is frequently noted. Left-sided pneumothorax is slightly more common than right. In some cases there are no physical signs suggesting a pneumothorax.

Two cases of bronchial asthma complicated by spon-

taneous pneumothorax are reported. In both cases there were associated chronic bronchitis and pulmonary emphysema. In one case the diagnosis of spontaneous pneumothorax was not made during the asthmatic attack because sufficient importance was not attached to the patient's statement that there was a sudden change in the character of his dyspnea. In the other case a roentgenogram, taken on admission to the hospital and not reported until after the patient's death, revealed the pneumothorax.

No definite outline of therapy can be given, since individual cases vary greatly in respect to associated pulmonary and interstitial emphysema, bronchial infection, and numerous other factors. Most authors favor conservative management.

Investigation of Pneumothorax and Respiratory Function at Altitude. Eric W. Peterson, Basil S. Kent, Howard R. Ripley, and David R. Murphy. Canad. M. J. **50:** 520–523, June 1944.

Proof has been presented by various writers that a pneumothorax expands at altitude in accordance with Boyle's law. Because of their importance in air transport of the wounded, the effects of this expansion on respiratory function were studied by the authors on human subjects with induced pneumothorax.

Two adapted ambulatory patients were placed in a decompression chamber, and ascent was made at the rate of 1,000 feet per minute, the patients receiving excess oxygen from the ground level. Chest roentgenograms were made, arterial blood oxygen saturation was estimated with a Millikan oximeter, and pulse and respiratory rates were recorded at ground level and at 5,000-foot intervals.

The first subject was a 56-year-old male with a 20 per cent pneumothorax on the right. At 20,000 feet the pneumothorax increased to 75 or 80 per cent. The oximeter percentage of oxygen dropped from 100 to 97 per cent; the pulse rate rose from 100 to 112, and the respiratory rate from 18 to 20 per minute. X-ray examinations showed negligible mediastinal shift. The patient complained of no untoward symptoms other than a sense of fullness in the right chest at 18,000 feet.

The second subject, a 21-year-old male, had a 50 per cent pneumothorax on the right side. At 15,000 feet the collapse had increased to 90 per cent. The oxygen saturation dropped from 100 to 90, the pulse rate rose from 116 to 168, and the respiratory rate from 24 to 36 per minute. Ascent was not carried above 15,000 feet because of the respiratory embarrassment, a frequent dry, irritative cough, and a feeling of tightness in the right chest. A more pronounced mediastinal shift was observed than in the first subject.

These observations show that, in so far as the mechanical factors of lung expansion influence blood oxygenation, a considerable quantitative difference exists between the ability of a smaller and a larger pneumothorax to withstand altitude, even under circumstances in which the reduced oxygen tension of altitude has been fully compensated; also, the larger the pneumothorax, the more pronounced the mediastinal shift. It is recommended, therefore: (*a*) that assessment of pneumothorax size be made before transport by air and (*b*) that large pneumothoraces be reduced prior to ascent; also (*c*) that flying altitude be taken into consideration; (*d*) that cough be allayed where present; (*e*) that oxygen be given from ground level where possible.

H. H. WRIGHT, M.D.

Diagnosis and Treatment of Lung Abscess. Symposium. T. Holmes Sellors, L. G. Blair, and L. E. Houghton. Brit. J. Radiol. **17:** 165–176, June 1944.

This symposium on pulmonary abscess was opened by Sellors, who discussed the surgical aspects. He pointed out that the weight of evidence at present is in favor of an inhalation or bronchial embolic causation rather than a blood-borne infection. The infected material is inspired into a terminal air tube. Atelectasis occurs distal to the obstruction thus produced, and infection quickly follows. The situation of the average abscess is peripheral. Rupture into the pleural sac is rare.

The blocked bronchus becomes patent if the plug liquefies, but as a rule the opening is so narrowed by edema and granulation tissue that drainage is not adequate. Bronchoscopy may empty the larger bronchi but rarely can drain the abscess. Bronchography is contraindicated in the earlier stages, as the oil will obstruct the opening in the bronchus and the residue will prevent radiological assessment of the progress of the disease.

Abscesses are most frequently found in the posterior part of the upper lobes and the apex of the lower lobes, because of the anatomical distribution of the bronchi.

Conventionally abscesses are treated for four to six weeks by postural drainage. About 25 to 30 per cent may undergo a spontaneous cure. If, however, the abscess increases in size or the general condition of the patient deteriorates, surgical treatment is indicated, and this should not be delayed too long. Too often surgical drainage is postponed until the abscess has become chronic and the cavity is epithelialized. The surgeon should be called into consultation as soon as the diagnosis is made.

Blair, continuing the discussion from the radiologic point of view, classified pulmonary suppuration into four groups: pyogenic lung abscess, chronic suppurative pneumonitis, multiple pyemic abscesses, and chronic lung abscess.

An acute localized pyogenic lung abscess is usually situated peripherally, with a fluid level and a surrounding area of consolidation. Encysted pleural effusion which has ruptured into a bronchus, diaphragmatic hernia, lung cysts, tuberculosis, and disintegration of pulmonary tissue distal to bronchial carcinoma may give similar appearances.

Suppurative pneumonitis and multiple pyogenic abscesses do not present diagnostic problems. Chronic lung abscesses may be present for many years. These are abscesses which have become partially healed and in the process have become epithelialized. Bronchograms show the lattice-like appearance that has led to the term *Gitterlunge* in the German literature. Differentiation from bronchiectasis is important.

The symposium was closed by Houghton, discussing the clinical aspects. He classifies lung abscesses in a general way as primary and secondary. Primary abscesses result from breakdown of areas of pneumonitis. Those of secondary type follow the inhalation of septic material or septic emboli. No single organism can be held responsible. It is generally held that anaerobic organisms are more frequently found in the putrid type and aerobic in the non-putrid.

Abscesses tend to occur more frequently in men than in women. The peak of age incidence is between forty and sixty. Dental infection and pyorrhea are common accompaniments.

The onset may be insidious, with upper respiratory infection and slight fever, or it may be abrupt with chills and fever. Chest pain and hemoptysis are common. The sputum soon becomes purulent. Toxemia is variable. The chief complication is rupture into the pleural cavity.

The non-surgical treatment is postural drainage with general sanitarium care as for tuberculosis.

SYDNEY J. HAWLEY, M.D.

Dermoid Cysts and Teratomata of the Mediastinum. N. Lloyd Rusby. J. Thoracic Surg. **13:** 169–222, June 1944.

Six new examples of proved dermoid cyst or teratoma of the mediastinum are recorded. An extensive and well organized summary of the world literature is presented, and a complete bibliography is included. Roentgenograms of four of the cases are reproduced.

The first tumor of this type recorded was made the subject of an address to the Medico-Chirurgical Society of London on Nov. 25, 1823, by J. A. Gordon. Up to the end of 1939, 245 cases had been reported.

The position of these tumors is in the anterior mediastinum, but they generally encroach on one or other side of the thorax. There are two types: the dermoid type and the solid type. The dermoid is the simpler and commoner, consisting usually of one cystic cavity containing sebaceous material. Microscopically it is simple and benign but may become malignant. The solid teratomata contain all three germinal layers and are more prone to be malignant. They are the source of 70 per cent of the malignant tumors of this type.

A long discussion of the pathogenesis, clinical features, physical findings, sputum examinations, etc., is presented, but need not be abstracted here. In the radiological discussion the following points are brought out. It is expected that many more of these tumors will be discovered by the mass chest surveys now being conducted. A lateral view is essential in addition to the usual postero-anterior projection. The tumors have a clear-cut edge and are usually circular or globular but may be irregular and lobulated. Calcification, teeth, or plaques of bone may be present. Fluid levels may be observed when bronchial communication exists and, even in the absence of air, a level has occasionally been demonstrated due to separation of the fat in the cyst from the aqueous content. Bronchography helps very little in the diagnosis but may be of value in showing the presence of bronchiectasis as a complication. Kymography and tomography have been of little value. Fluoroscopy is valuable in locating the mass.

The Aschheim-Zondek test may prove useful in differential diagnosis when positive. Bronchoscopy is of little value. A complete discussion of the differential diagnosis is presented. The paper is completed with a long discussion on the complications and treatment. Surgical removal is advised in all cases unless contraindicated for other reasons. There is no known instance of cure of a malignant teratoma.

HAROLD O. PETERSON, M.D.

Rheumatic Pericarditis in Early Childhood. Samuel L. Ellenberg and Harold Cook. J. Pediat. **24:** 662–670, June 1944.

A case of rheumatic pericarditis in a colored boy, 2 1/2 years of age, is reported. This patient is the youngest on record to have recovered from this condition.

On the night before admission to the hospital, the child, hitherto perfectly well, suddenly complained of generalized abdominal pains. Four hours later he was feverish and breathed with difficulty. He appeared acutely ill when first seen, with labored respiration, hypertrophied and congested tonsils, and injected pharynx. The abdomen was moderately distended and somewhat rigid but there was no localized tenderness. Rectal examination elicited tenderness on the right side. A roentgenogram of the chest was normal.

On the day following admission a diminution of the percussion note anteriorly and posteriorly in the left lower lung field, with a corresponding decrease in breath sounds, was noted; this was interpreted as indicating an early lobar pneumonia. X-ray examination of the chest now showed enlargement of the cardiac silhouette, especially on the left side, with clear lung fields, and an electrocardiogram confirmed the clinical impression of rheumatic pericarditis. The heart at this time was enlarged, the heart sounds did not appear muffled, a friction rub was not heard, and no murmurs were present.

Despite large doses of salicylates, the size of the heart continued to increase. The child was very dyspneic even in the oxygen tent, and restlessness had to be controlled with morphine and sodium phenobarbital. Rapid digitalization was employed when the liver became tender and the first evidences of congestive failure presented themselves, but no appreciable effect of this medication was observed. On the sixth day 10 c.c. of pericardial fluid was withdrawn; this proved to be sterile but showed a leukocyte count of 8,000, with 80 per cent lymphocytes.

A pericardial friction rub and muffled heart sounds were first heard one week after admission, when the clinical findings and roentgenograms indicated an increase in the size of the heart. The general condition became much worse; on the fourteenth day, edema of the ankles appeared. On the seventeenth day the patient began to improve: the edema of the ankles subsided, the dyspnea disappeared sufficiently to enable him to stay out of the oxygen tent, and the toxicity decreased. On the twenty-first day of the illness a systolic murmur, not transmitted, was heard for the first time at the apex, and the cardiac shadow appeared normal in size except for widening of the superior portion. At the time of the patient's discharge, a faint soft systolic murmur at the apex, not transmitted, was the only indication of possible cardiac damage. At the last follow-up examination, nine months after the onset of the illness, roentgen and laboratory studies were essentially normal.

This case presented a difficult diagnostic problem. During the first two days the abdominal pain and toxemia were so strongly suggestive of an acute condition of the abdomen that surgeons were twice called into consultation. The second x-ray examination of the chest, the day following admission, led to the correct diagnosis. Roentgenograms are reproduced.

Purulent Pericarditis Complicating Pneumonia. Recovery in an Infant Following Therapeutic Aspiration and the Development of Pneumopericardium. M. Cooperstock. J. Pediat. **24:** 656–661, June 1944.

A case of purulent pericarditis complicating pneumonia in an 8-month-old infant is reported. The pa-

tient was admitted to the hospital on Jan. 21, 1939, with the history of an upper respiratory infection three weeks previously. Four days before admission, anorexia, restlessness, and respiratory difficulty appeared rather abruptly. Examination showed dyspnea, cyanosis, and extreme restlessness. The respiratory rate was 48. There was a lag of respiratory movement on the left. Dullness to flatness was present over the entire left chest both anteriorly and posteriorly, associated with bronchial breathing over the upper lobe posteriorly and in the axilla. Crepitant râles were audible over the upper left chest anteriorly and posteriorly. The apex beat could not be distinguished on palpation, and the heart sounds were scarcely audible. The position and size of the heart could not be determined.

Roentgen examination showed a diffuse, homogeneous shadow over practically the entire left chest. There was only a small area of transparent lung in the costophrenic angle. A small patch of pneumonia was present in the right apex. The smooth curve of the right cardiac border with some appearance of broadening at the base was strongly suggestive of a pericardial effusion.

On Jan. 24, because of increased cyanosis and dyspnea, the patient was put in an oxygen tent. There was a considerable suppression of sounds over the left lower chest posteriorly. A left thoracentesis yielded only 4 c.c. of thin blood-tinged fluid. On Jan. 31, the condition suddenly became critical, with the development of abdominal distention, increased cyanosis, and labored breathing. After the employment of emergency measures, aspiration of the pericardial sac was performed, with removal of 135 c.c. of thick, greenish pus, followed by immediate relief. A second aspiration was attempted later on the same day, but no pus was obtained. A third pericardial tap, five days later, likewise yielded no fluid.

A roentgenogram of the chest on Feb. 8 showed the unexpected presence of a small amount of air in the pericardial sac. There was still evidence of residual pneumonia in the upper lobe of the left lung. On Feb. 11, a pericardial tap yielded approximately 10 c.c. of air and only 2 c.c. of thin yellowish fluid. On Feb. 15, x-ray examination revealed a pronounced distention of the pericardial sac and compression of the heart by air. The upper lobe on the left still showed a pneumonic shadow. The cardiac area was hyperresonant, with scarcely audible heart sounds.

Two days later, because of the persistent dyspnea, 175 c.c. of air was slowly aspirated from the pericardial sac under fluoroscopic guidance. Immediate improvement in the child's breathing followed. A check-up film of the chest five minutes later showed practically complete refilling of the pericardial sac with air but no further aspirations were attempted. The patient's condition steadily improved. Roentgenologically there was a progressive reduction of the pneumopericardium, and roentgenograms six weeks after its original detection revealed the presence of a small amount of air demonstrable only in the lateral projection. Subsequent examinations showed the infant to be in good health.

Whether the pneumopericardium in this case was of spontaneous or accidental origin is not known. Its slow appearance, together with the immediate refilling of the pericardial cavity with air following aspiration, indicates at least that a fistulous communication had been established between the pericardial sac and respiratory tract. The single large therapeutic aspiration of the pericardial sac and the subsequent gradual development of pneumopericardium appear to have operated together in bringing about the favorable outcome. This case suggests the possibility that therapeutic aspiration followed by induced pneumopericardium may, under certain circumstances, serve as a conservative method of treatment in purulent pericarditis.

Ball Thrombus in the Right Auricle of the Heart, with a Description of the Symptoms Produced. Irving S. Wright, Joseph E. Flynn, and Kenneth L. Druet. Am. Heart J. **27:** 858–869, June 1944.

The literature reveals 35 authentic cases of ball valve thrombus of the heart: 34 in the left auricle and 1 in the right ventricle. The author's case is said to be the first to be recorded of such a thrombus in the right auricle. It was found in a white male of forty-seven, was diagnosed, and was verified postmortem. The thrombus measured 6.8 cm. in diameter.

An unusual series of findings led to the deduction that a movable thrombus was acting as a ball valve over the tricuspid orifice. This syndrome may lead to its consideration in other cases.

The clinical picture showed repeated bouts of heart failure with signs of a tricuspid lesion and remarkable responses to bed rest and digitalis. Roentgenograms of the heart made six months and two days prior to death showed an enlarged heart with a marked prominence of the right auricular border. Another, made the day before death, showed reduction in the size of the heart, with disappearance of the right auricular shadow behind the sternum.

The rapid changes in the severity of the tricuspid syndrome with the sudden reduction in the size of the heart led to the conclusion that a large auricular thrombus was present, exerting a ball-valve action.

The syndrome which should lead to a consideration of a ball thrombus in the right auricle includes: (1) dusky cyanosis of face and neck; (2) engorgement of the veins of the neck, with a systolic pulsation; (3) severe dyspnea of the oxygen hunger type; (4) enlargement of right heart; (5) presence of old rheumatic heart disease; (6) auricular fibrillation; (7) mitral stenosis (not essential); (8) murmur of tricuspid insufficiency or stenosis; (9) engorgement of the liver with systolic pulsation; (10) a series of striking variations of this syndrome from extreme severity to relatively normal conditions and vice versa, within short periods of time, six to forty-eight hours. HENRY K. TAYLOR, M.D.

Aneurysm of the Ventricle of the Heart, with the Report of a Case. T. J. F. Frank. M. J. Australia **1:** 527–531, June 10, 1944.

At autopsy, ventricular aneurysm is said to be found in approximately 9 per cent of patients dying from cardiac infarction. Rarer causes are syphilis, infective endocarditis, rheumatic carditis, congenital lesions, and trauma. In cases following coronary thrombosis, inadequate bed rest is thought to be a predisposing factor. This opinion is substantiated by both experimental evidence and reported cases. Following ligation of the descending branch of the left coronary artery, thin ventricular scars with aneurysmal bulging occur in dogs if the animals are exercised three days

postoperatively. If they are rested for six days, a good scar without thinning usually results.

Radiological demonstration of the aneurysm is the most valuable of all diagnostic aids. Fluoroscopic screening not only aids in determining the site of the aneurysm, but also reveals the type of pulsation. Paradoxical pulsations indicate a weakened area of myocardium, while diminished pulsations may be observed if the aneurysm is filled with organized clot or surrounded by thickened pericardium.

Fluoroscopic screening also enables the best position to be found for taking x-ray pictures. Thus a lesion of the anterior wall is best seen in the antero-posterior and right oblique positions; if the aneurysm projects forward, either it may appear as a distinct bulge, or more often its upper margin forms a more or less abrupt ledge or shelf on the anterior contour of the heart. If the posterior wall of the heart is affected, an antero-posterior film may reveal a diffuse bulge at the upper part of the left ventricular border, usually separated from it by a notch; these aneurysms are, as a rule, at a higher level than those on the anterior wall. A film in the left oblique position reveals a posterior projection from the upper part of the left ventricle indenting the barium-filled esophagus. The density of posterior aneurysms may be the same as, but is frequently lighter than, the cardiac shadow.

Infarction of the membranous septum may yield to form an aneurysm bulging into the right ventricle; this results in gross enlargement of the right side of the heart with no apparent cause.

Sometimes x-ray examination will reveal calcification within the left heart border or in the clot. This calcification is limited to the left ventricle and is linear, whereas in chronic constrictive pericarditis the calcification is thicker, more irregular, and not restricted to the ventricle.

The author reports a case in a fifty-three-year-old white male, which had been under observation for a period of twenty-one months.

ELLWOOD W. GODFREY, M.D.

THE DIGESTIVE SYSTEM

Major Motility Patterns of the Child's Digestive Tract: A Review. Irving J. Wolman. Am. J. M. Sc. **207:** 782–804, June 1944.

This is a useful review of recent contributions to the subject of major patterns of digestive tract motility in infancy and childhood. The bibliography contains 124 references.

Incidence of Peptic Ulcer. Marcel Patterson. New Orleans M. & S. J. **96:** 570–591, June 1944.

That peptic ulcer is a common disease is widely recognized. Yet when one attempts to analyze the data of various authors on its incidence, one is struck with the extreme lack of agreement. This discrepancy is explained, at least in part, by the variation in geographic conditions and lack of uniformity of method used in conducting the surveys.

The author has made an exhaustive review of statistical surveys in an attempt to determine the frequency of peptic ulcer in this country and in other countries, the anatomic incidence of ulcer, its sex and age incidence, occupational incidence, incidence in various body types, and incidence of complications.

Reported large series in America show a wide variation from 0.06 per cent (clinical diagnosis) of hospital admissions, to 20 per cent (x-ray diagnosis) in consecutive gastro-intestinal examinations. The percentage of ulcers found at autopsy occupies a midway position between the two extremes. It is believed that many patients with unrecognized ulcer are admitted to hospitals for other conditions. The author concludes that in America approximately 12 per cent of all persons have peptic ulcer sometime in their lives.

Foreign statistical reports show great variability in the incidence of peptic ulcer from country to country. The reported incidence in necropsy material, as given by Rutimeyer (1906), is surprisingly low in Russia, 0.8 per cent, while in Denmark it is 16.7 per cent. Peptic ulcer is common in India, but is reported to be 15 times more common in the southern than in northern part. In the native Malays of Java and Sumatra the incidence is very low, while among the Chinese of this region the frequency is more or less the same as in the western world. Statistics for other geographical areas are cited from the literature.

The ratio of gastric to duodenal ulcer is estimated at 1:4. In America and England peptic ulcer predominates in the male in the ratio of approximately 4:1, and predominance in the male holds for other countries except Java.

Laborers and unemployed classes showed the highest occupational incidence in most series. The opinion, frequently held, that ulcer is more common among people with greater responsibility and mental strain still awaits proof. There is no reliable evidence that a body type peculiar to peptic ulcer exists. Hemorrhage is the most frequent of reported complications, but perforation is more serious.

The unusually high incidence of peptic ulcer in the Armed Forces in this war (30 per cent or over of cases of dyspepsia) indicates it to be a problem of national importance. It is probable that the war has merely called to attention numerous cases of ulcer which existed previously but were not recognized.

A bibliography of 82 references is appended.

H. H. WRIGHT, M.D.

Perforated Peptic Ulcer. A Follow-Up Study of One Hundred Cases. Ashbel C. Williams. New England J. Med. **230:** 785–790, June 29, 1944.

This investigation was undertaken to determine the fate of persons operated upon for perforated peptic ulcers. One hundred cases were re-studied with this object in mind.

There were 97 males and 3 females in this series. Twenty-seven were in the fourth decade and 32 in the fifth decade of life. In 54 cases the ulcer was gastric, with 42 prepyloric; in 40, duodenal; and in 3, pyloric. In all cases the ulcer was on the anterior wall.

The follow-up results were graded as excellent in 28 cases, good in 27 cases, fair in 22 cases, and poor in 23 cases. It was found that the longer the pre-perforation period of complaint, the poorer the result. The relation of diet to postoperative symptoms seemed to be of limited significance, although indiscretions in eating appeared to precipitate symptoms in some patients.

Postoperative x-ray examination showed complete agreement with the symptomatology in 69 per cent of the series, slight divergence in 14 per cent, and com-

plete disagreement in 16 per cent. The disagreement was believed to be due to the difficulties of examining postoperative stomachs and possibly to the presence of silent ulcers.

Three patients had a second perforation. In one patient a carcinoma developed, apparently in a gastric ulcer, after two years of freedom from symptoms and a negative x-ray examination.

JOHN B. MCANENY, M.D.

Duodenal Diverticulum Simulating Gallbladder Colic. Report of a Case. Hugh F. Hare and Richard B. Cattell. S. Clin. North America **24:** 635–639, June 1944.

A patient with symptoms of gallbladder colic, namely pain in the right upper quadrant radiating to the right shoulder and associated attacks of jaundice, was found at operation to have a duodenal diverticulum containing stones. Though this patient had had three previous operations and numerous gastro-intestinal x-ray studies, the diverticulum had not previously been detected. It did not fill at the time of the fluoroscopic examination and was overlooked in the original interpretation of the films. A careful review of the six-hour film, however, revealed a diverticulum measuring 3 × 4 cm. in the only portion of the proximal bowel which contained residual barium. The neck of the diverticulum was not clearly shown, but at operation the narrowed neck of the proximal portion was noted.

The importance of studies of the common duct and duodenal loop in cases of unexplained obstructive jaundice following cholecystectomy is emphasized. In most instances the cause of the obstruction is in the common duct, but a duodenal diverticulum containing gallstones may produce symptoms of obstruction, as shown by the case presented.

Mesenteric Pouch Hernia Simulating Paraduodenal Hernia. Ray B. McCarty and Arthur J. Present. Surg., Gynec. & Obst. **78:** 643–648, June 1944.

A 27-year-old soldier, complaining of abdominal pain and tenderness, was admitted to an Army Hospital. During the previous three months he had experienced two attacks of acute abdominal pain, and a feeling of heaviness in the lower abdomen persisted. Roentgen study showed the small intestine coiled in a circular mass, which led to the diagnosis of probable paraduodenal hernia. At operation a broad and thickened duodenojejunal fold was found overlying the mouth of a large mesenteric sac, which contained practically the entire small bowel with the exception of a very short proximal loop of jejunum and the terminal three feet of ileum. The opening of the sac did not involve the duodenum and was anterior to the mesenteric vessels. The wall of the sac consisted of two layers of thinned-out peritoneum, formed by a pouching of the proximal jejunal mesentery.

The origin of this hernia is believed to have been an unusually long pre-arterial mesentery in the region of the proximal jejunum, which formed a pouch during the second stage of embryonic rotation which engaged the small intestine. The small bowel was then incarcerated by the early fusion of the upper jejunum, as represented by the thickened duodenojejunal fold found at operation. Then, as growth proceeded, the hernia enlarged.

No characteristic symptoms are noted in mesenteric pouch hernias. Occasionally there is a history of repeated attacks of intestinal obstruction suggestive of recurrent temporary volvulus, but the majority of cases reported have been found at autopsy or incidentally in the course of abdominal operations, and have given no previous history of gastro-intestinal distress. Rarely a soft mass has been felt in the abdomen, but this in itself cannot lead to the diagnosis.

Roentgen examination often makes diagnosis possible. The grouping of the small bowel loops in the sac, their failure to separate on palpation, and their lack of essential change in relationship on change of position of the patient, all lead to the fluoroscopic diagnosis. Films made with the patient upright indicate an absence of small bowel loops in the pelvis and flanks; lateral films made in the upright position show the "pocketing" of the loops within the sac. As the result of inclusion within the confining sac, motility of the bowel is decreased, and the barium progresses slowly. The condition may be confused with peritoneal adhesions or a short mesentery, but adhesions should show sharper angulations and a more diffuse pattern. In the presence of a short mesentery, separation of the loops by palpation should be possible, changes in their relationship should follow change of position of the body, and the motility of the bowel should be normal. Pelvic masses may displace the small bowel upward, but pressure from below will produce a convex deformity of the lower margins.

The treatment of hernias in the region of the duodenojejunal juncture is surgical, and an early diagnosis is desirable if it leads to an elective instead of an emergency operation. At times adhesions or vascular structures prevent satisfactory procedures, and the sac cannot always be removed, nor its neck be properly widened. In obstructive cases a lateral enteroanastomosis, an ileocolostomy, or an enterostomy may be necessary without disturbing the hernial sac or its contents.

D. W. TOWNSEND, M.D.

Intestinal Gas Volumes at Altitude. Eric W. Peterson, Basil S. Kent, and Howard R. Ripley. Canad. M. A. J. **50:** 523–526, June 1944.

The transportation of the war wounded by air, particularly those with abdominal injuries or suffering from intestinal ileus or distention, brings up the question of expansion of intestinal gases at altitude. Gas under the influence of reduced pressure at altitude behaves in accordance with Boyle's law. This is evidenced practically in persons accustomed to altitude flying by the frequent occurrence of abdominal distention with concomitant discomfort, both of which are relieved by belching or the passage of flatus.

In the present investigation quantitative methods were applied to the determination of the degree of gaseous expansion and measurement of the possible resistance of the abdominal parietes to the swelling of gas-filled organs with ascent to altitude. A human subject was "decompressed to 30,000 feet" in a decompression chamber after introduction of 400 c.c. of air into the stomach. X-ray films were made with the subject in sitting position at ground level and at intervals of 5,000 feet. At 30,000 feet there was a sensation of fullness in the stomach, promptly relieved by belching. Roentgenograms showed progressive increase in the air bubble in the stomach with ascent, in accordance with Boyle's law.

Further x-ray studies were carried out on cats. Barium-impregnated bladders containing 50 c.c. of air were inserted into the peritoneal cavity of the animals;

decompression was carried out under a bell jar and films were made at zero, 10,000, 15,000 and 20,000 feet. During decompression, swelling of the abdomen was observed. The bladders became greatly distended as altitude increased. These experiments on cats demonstrated that expansion of gas in the abdomen is not resisted to any extent by the abdominal parietes.

The significance of the expansion of intestinal gas in the air transport of wounded men, from the point of view of peritoneal soiling, remains to be investigated. At present its seriousness at reasonable altitudes is conjectural. It may be of minor consequence compared with the soiling which occurs while the wounded are being collected from the battle field, or which would occur during jostling over a rough terrain in an ambulance, with greater delay in definitive surgical treatment. Routine precautions (enemas; insertion of rectal and stomach tubes) should be taken in all cases where indicated, particularly if the flight is to be at a high altitude. H. H. WRIGHT, M.D.

Pancreatic Lithiasis. Thomas C. Jaleski. Ann. Int. Med. **20:** 940–947, June 1944.

The outstanding symptom of pancreatic lithiasis is epigastric pain. This may be severe in nature and intermittent, or it may be mild and practically constant. Occasionally, it radiates to the back or either shoulder. Diarrhea and steatorrhea are of frequent occurrence, usually accompanying the colicky pain and vomiting. A history of chronic alcoholism is obtained in some 45 per cent of cases. Liver disease and disturbances in the carbohydrate metabolism are frequently associated. In the acute phase of pancreatitis, an increase in the serum amylase and lipase has been reported.

The two cases recorded here present different aspects of the clinical syndrome. One patient, an alcoholic, showed early disturbance in sugar metabolism, yet the pancreatic disease presented no serious threat to life. The other, who had no history of alcoholism, succumbed to progressive disease of the pancreas, but serious disturbance in the sugar metabolism developed only a few days prior to death. Roentgenograms showed the presence of stones in both cases.

STEPHEN N. TAGER, M.D.

THE SKELETAL SYSTEM

Epiphysial Dysgenesis Associated with Cretinism in a Premature Infant. Maurice L. Blatt, Mary Zeldes, and James Goodfriend. Am. J. Dis. Child. **67:** 480–484, June 1944.

A well illustrated case of epiphyseal dysgenesis associated with cretinism is reported. The peculiar appearance of the premature infant suggested diagnoses of cretinism, chondrodystrophy, hypertelorism, and mongolism. Pertinent laboratory data included the presence of 233 mg. of cholesterol per 100 c.c. of the mother's plasma (normal 160 mg. to 200 mg.) and abnormal excretion of creatine and creatinine in the infant's urine. Roentgen studies showed multiple punctate calcified foci in all the epiphyseal centers of the long bones as well as those of the vertebrae. The patient had recurrent bouts of bronchopneumonia responding to sulfathiazole therapy, but died at three months of age. The complete autopsy report is included in the article and confirms the clinical diagnosis. The patient apparently improved on administration of thyroxin, but succumbed to the repeated infection.

The roentgen reproductions include the entire skeleton with special views of the long bones and show good detail. LESTER M. J. FREEDMAN, M.D.

Osteochondritis Dissecans. George H. Stein, R. G. Ikins, and Frederick C. Lowry. Am. J. Surg. **64:** 328–337, June 1944.

Five cases of osteochondritis dissecans are presented and illustrated by roentgenograms; the findings are characteristic. The authors review the literature and quote Burr's description of the radiologic picture (Canad. M. A. J. **41:** 232, 1939. Abst. in Radiology **35:** 757, 1940).

Importance of the Early Recognition of Congenital Dislocation of the Hip. Vernon C. Turner. Wisconsin M. J. **43:** 613–617, June 1944.

Early diagnosis of congenital dislocation of the hip is important in that it is curable in direct proportion to the age at which adequate treatment is begun. Studies of end-results of treatment based upon observation of patients for five to twenty years indicate that the results leave much to be desired. The percentage of cures based on anatomic and functional considerations has been under 50, though Putti reported 95 per cent functional and anatomic cures in a large series of cases from the Rizzoli Institute, in Italy. This excellent result is attributed to early recognition and treatment.

In physical diagnosis of congenital dislocation of the hip the following signs have been of most value: (1) apparent shortening of the extremity; (2) decrease in range of abduction on the affected side; (3) piston motion (on the normal side there is some excursion of the femur on push and pull, but on the dislocated side this will be much greater); (4) asymmetry of skin folds about the thigh; (5) asymmetry of the femoral head; (6) position of the trochanter near the anterior superior iliac spine. Signs of bilateral dislocation are: (1) wide perineum; (2) apparent lordosis, due to unusual fullness of the buttocks produced by posterior dislocation at the hips; (3) unusually deep skin folds of the thigh; (4) trochanters unusually near the level of the anterior superior iliac spine; (5) failure to palpate the femoral head in the acetabulum. These signs are present, however, only to the degree that there is displacement and upward riding of the femur.

The interpretation of roentgenograms may be exceedingly difficult, particularly since a large proportion of the hip is not ossified in infancy. The film should be taken with the patient flat on his back, the legs in contact, the hips extended, the patellae pointing straight upward and the tube centered directly over the symphysis pubis. The following roentgen signs are useful.

(1) The epiphysis should lie medial to a perpendicular drop from the outer lip of the acetabulum and below a horizontal line crossing the lowermost part of the ilium (Perkins' line).

(2) The acetabular roof is more sloping and the acetabular fossa shallower than normal.

(3) The epiphysis is smaller than normal and appears at a later date.

(4) The smooth curve of Shenton's line is broken

(5) The medial margin of the proximal metaphysis lies at a greater distance from the acetabulum than it does on the normal side.

The longer treatment is delayed the greater are the pathologic changes in the capsule, the ligaments and tendons, and other soft structures about the hip, and the greater are the adaptive changes in the bones, making reduction more difficult to obtain and maintain. Aseptic necrosis of the head is more likely to occur in late reduction, and anteversion of the neck of the femur increases. H. H. WRIGHT, M.D.

Fractures of the Neck of the Femur: An Analysis of 157 Intracapsular and Extracapsular Fractures. Irwin E. Siris and John D. Ryan. Surg., Gynec. & Obst. **78:** 631–639, June 1944.

A series of fractures of the upper end of the femur is analyzed, and the advantages of immediate internal fixation are demonstrated.

Intracapsular Fractures: The authors believe that in the presence of an intracapsular fracture operation should be done immediately instead of waiting for the patient's condition to improve or to see if he is going to survive, as the dangers of the complications attendant upon conservative treatment outweigh those of operation. Immediate transfixion helps to preserve the blood supply to the fragments. The more proximal the fracture line the more urgent the need for immediate fixation. In the poor risk case the surgeon should be satisfied with less than perfect reduction rather than subject the patient to further manipulation. In cases of this type, fixation is recommended if there is 75 per cent reduction.

The authors use the cannulated, three-flanged Smith-Petersen nail. Local anesthesia is preferred in the aged and the depression incident to morphine premedication should be avoided. Reduction is accomplished by the Leadbetter maneuver and the extremity is then fixed on the traction table. Insertion of the guide wires is aided by a skin clip over the middle of the inguinal ligament and another 1 inch below and 1/2 inch lateral to the femoral artery.

Three sets of x-rays are considered indispensable: the first to check the reduction and locate the skin clips in relation to the femoral head, the second to locate the position of the guide pins, and the third to check the position of the flanged nail. The use of two x-ray machines which can be left in place saves time and prevents disturbing the drapes.

A burr hole is drilled 1 inch below the protruding ridge of the lower end of the greater trochanter and the edges are bevelled to prevent deflection of the guide wires by the cortex. After determining the relation of the skin clips to the head, two guide wires are inserted. The operator should be able to push them without drilling until they strike the head. In high subcapital fractures the guide wire is drilled for a short distance into the acetabulum to prevent rotation when the nail is inserted. The second set of roentgenograms is then taken and the better of the two guide wires is used for the insertion of the nail.

A light plaster boot to the knee with a horizontal board behind the heel is applied to insure against outward rotation. Turning of the patient on the uninjured side should be prohibited, as this predisposes to disengagement of the nail. The patient is allowed out of bed in a week.

Extracapsular (Intertrochanteric) Fractures: Extracapsular fractures made up 64 per cent of the authors' series of 100 cases. This type is more serious because of greater shock and more rotation, deformity, and soft-tissue damage. It also carries a higher mortality (22 per cent) than the intracapsular variety (8.7 per cent).

Bilateral Russell traction is the simplest form of treatment if the patient can stand the prolonged stay in bed. Transfixion presents difficulties, because there is usually comminution and the grip on the distal fragment is inadequate. Neither Moore pins nor the Smith-Petersen nail alone will give a satisfactory result. A combination of a Hawley bar and a Smith-Petersen nail proved fairly satisfactory, but the blade plate designed by Moore and Blount is the treatment of choice.

The authors' experiences definitely indicate that external pin fixation is unsatisfactory and hazardous. The operation itself presented no difficulties and the patients showed practically no shock or reaction to the procedure. However, the friction of the soft tissues against the pins caused discomfort and increased the nursing care needed. Seepage and infection complicated the cases, and the mortality was high.

J. L. BOYER, M.D.

An Analysis of Colles's Fracture. S. C. Rogers. Brit. M. J. **1:** 807–809, June 17, 1944.

In introducing his subject the author points out that there is a very wide variation in so-called Colles's fractures and that, furthermore, there is a notable lack of description of these variations in most standard texts on the subject. After a short description of the anatomy of the human wrist, a series of 219 fracture cases is classified as follows: (A) simple fractures, 59 cases; (B) fractures with an oblique posteromedial fragment, 108 cases; (C) comminuted Colles's fractures, 35 cases; (D) with vertical fracture of the radial styloid, 11 cases; (E) with transverse fracture of the base of the radial styloid, 2 cases. Treatment consists in disimpaction by strong traction, application of plaster, and graduated exercises. Q. B. CORAY, M.D.

OBSTETRICS AND GYNECOLOGY

Radiological Pelvimetry. A New Zealand Study. E. Peter Allen. New Zealand M. J. **43:** 116–129, June 1944.

The author presents the internal pelvic measurements of a series of 220 New Zealand women referred to the New Plymouth Hospital for radiological examination. He believes these figures to be fairly representative of New Zealand-born women as a whole and compares them to series reported by Nicholson (J. Obst. & Gynaec. Brit. Emp. **45:** 950, 1938), representing "a fair sample of the women of child-bearing age in Gloucestershire and probably in rural England," and by Ince and Young (J. Obst. & Gynaec. Brit. Emp. **47:** 130, 1940) considered "a fair sample of London women of British parentage." A statistical approach is utilized, and the magnitude and source of error are indicated.

The author finds substantial agreement between the British authors, standard textbooks, and himself, in regarding the mean value of the transverse diameter of the inlet to be in the region of 133 mm. However, the mean value of the New Zealand obstetrical conjugate is significantly higher than that recently reported from England, both in rural and urban groups, and grossly larger than any textbook estimate. Since the racial background of the British group is compar-

able, Allen agrees with the suggestion of Thoms that adequate nutrition has more influence on pelvic shape than is generally thought, and further states that the shape of the pelvis is determined more by environment and diet than by inherited racial tendencies.

In the group of cases reported, labor was conducted by different doctors, and different indications for rendering active assistance obtained. There was, therefore, only slight correlation between measurements and the clinical course of labor.

ELLWOOD W. GODFREY, M.D.

GENITO-URINARY TRACT

Supernumerary Kidney with Clear Cell Carcinoma. Mark Exley and W. S. Hotchkiss. J. Urol. **51:** 569–578, June 1944.

The forty-sixth supernumerary kidney of the world's literature is here reported. The authors believe it the first authentic example containing a malignant growth.

The preoperative diagnosis of supernumerary kidney has been made only three times, and many cases have been discovered only at autopsy. Intravenous urography is not reliable, since the function of the kidney may be reduced or nil. Retrograde pyelography is usually needed, as in the present case. Symptoms are due to the disease affecting the extra kidney.

The age span of the reported cases is from nine months to sixty-seven years. Most of the symptoms have appeared in the second decade. The sexes are equally afflicted.

The abnormal kidney may be almost anywhere, but is usually below the normal organ. Several have been found in the true pelvis. The majority of ureters fuse before reaching the bladder. If this is not the case, a diligent search must often be made to locate the third ureteral orifice, which may be found in bizarre locations outside the bladder.

Infection and calculus are the most frequent lesions. One case of malignant neoplasm has been previously recorded, but this is regarded as questionable.

The case reported by the present authors occurred in a 65-year-old man, who showed no metastases and recovered completely following nephrectomy.

EDWIN L. LAME, M.D.

Primary Epithelioma of the Ureter: Follow-Up Study of 18 Cases with the Addition of 9 New Cases. Virgil S. Counseller, Edward N. Cook, and Philip H. Seefeld. J. Urol. **51:** 606–615, June 1944.

The extent of the surgery performed and the inherent pathological grade of the tumor tissue are the two factors influencing the end-result in primary epithelioma of the ureter. This paper is a follow-up report of 18 cases, with consideration of the influence of these two factors in the results obtained.

Primary carcinoma of the ureter appears in the sixth and seventh decades of life, usually in the lower portion of the ureter, the majority of the patients being men. The outstanding symptoms are hematuria and pain, varying from a dull ache to renal colic. A mass is sometimes palpable. Diagnosis is made, or at least strongly suggested, by intravenous urography and retrograde pyelography. Occasionally the tumor can be seen peeping from the ureteral orifice on cystoscopy.

The treatment of choice is complete nephro-ureterectomy with removal of all the periureteral adipose tissue plus resection of the uretero-vesical section of the bladder. The authors emphasize the need for long cystoscopic follow-up, as tumors of the bladder may follow extirpation of the ureteral neoplasm with no apparent relationship.

These neoplasms are squamous-cell epitheliomas with a tendency toward papillary structure. The authors use the classification of Broder, grading them one to four with ascending malignancy. The grade is undoubtedly the main factor influencing the prognosis. Patients with tumors of the lower grades have done well under radical surgical treatment. Tumors of the higher grades, however, less frequent than those of the lower grades, have not responded well to any form of treatment. Seven of 10 patients with epithelioma of grades 1 and 2 are alive and well for periods ranging from four to thirteen years. Seven of eight patients with growths of grades 3 and 4 were dead within a two and one-half year span.

J. FRANCIS MAHONEY, M.D.

Thrombosis of the Renal Vein. William F. Melick and Alvin E. Vitt. J. Urol. **51:** 587–596, June 1944.

In children, renal vein thrombosis is almost always secondary to severe ileocolitis or gastro-intestinal upsets. In adults, such thrombosis is usually due to inflammation of the renal pedicle from perirenal suppurations, renal abscesses which have ruptured into the perinephrium, or secondary to a pyelonephritis. The thrombosis may also be secondary to an ascending venous thrombosis originating in either the veins of the pelvis or lower extremities.

The onset is usually sudden: there is fever, with pain and tenderness on the affected side. The kidney is enlarged, movable, and tender. Usually there are signs of infection and severe toxicity. Hematuria is present in almost every case. A history of previous colitis or thrombophlebitis is a common feature.

The author describes a case in which a retrograde pyelogram was secured a short time after the onset of the thrombosis, the first time a retrograde pyelogram has been normally made in such a case. The involved pelvis was poorly visualized, irregularly filled, and somewhat irregular in outline. Intravenous pyelography, which was used chiefly in the earlier reported cases could show only one thing, namely, lack of function. Retrograde pyelograms, if not obtained shortly after the onset of the thrombosis, will show complete failure of filling of the renal pelvis.

Immediate surgical removal seems to be the treatment of choice. Heparin or dicoumarin are recommended to prevent possible further extension of the thrombus formation.

DAVID KIRSH, M.D.

LEGAL ASPECTS OF RADIOLOGY

Radiology and the Law. S. W. Donaldson. Ohio State M. J. **40:** 517–520, June 1944.

The standard of the medical specialist is determined by physicians devoting special attention and study to the same branch in similar localities. The specialist is bound to keep abreast of the times, but may not go beyond the accepted methods of modern practice unless he is prepared to take the risk of establishing by his success the propriety and safety of his experiment.

Most malpractice suits are based on negligence and allege that the physician failed to comply with his implied contract or with one set up by statutory law. For example, the allegation may be a want of professional skill or knowledge. Negligence of a physician or surgeon cannot be inferred from a poor result alone. There must be evidence from expert witnesses to show improper and unskillful treatment in order to sustain a charge of malpractice. A physician may also be sued for malpractice because of the acts of his assistants or employees. A radiologist does not enjoy immunity if he is connected with a charitable institution.

A roentgenogram to be admitted as evidence must be verified, and the court must be satisfied that it represents a person or thing material to the case. Some jurists recognize the fact that the introduction of the film in itself means little, but its interpretation by an expert who has had years of training and experience in reading similar films is the important thing to consider.

The author advises that an appearance in court may be facilitated by (1) a familiarity with court-room procedure, (2) a thorough knowledge of the case history and all findings, (3) simple answers without volunteering testimony, and (4) adherence to the absolute truth. ELLWOOD W. GODFREY, M.D.

RADIOTHERAPY

NEOPLASMS

Cancer of the Lip. S. J. Douglas. Brit. J. Radiol. **17:** 185–189, June 1944.

During 1939, 71 cases of cancer of the lip were treated; 46 by contact therapy. All but one of the patients were males, chiefly outdoor laborers. The average age was 62, the youngest patient being 32 and the oldest 81. In every case the lesion was on the lower lip. Important factors in the etiology are oral sepsis and the presence of sharp tooth stumps, pipe smoking, and exposure to wind and sun. Most of the cancers develop on a leukoplakic or keratotic base. Fair skinned persons are particularly susceptible.

The average duration before treatment was started in the series reported was eight months. Ten cases were in Stage I (lesion less than 1.5 cm. in diameter); 44 cases in Stage II (greater than 1.5 cm. in diameter but not attached to surrounding structures); 17 cases in Stage III (invading or attached to surrounding structures). Seven patients had been treated by "cancer curers" with arsenic paste. Twenty-eight per cent had palpable lymph nodes when first seen. These disappeared in 9 cases following treatment of the primary lesion and correction of oral sepsis. In 7 cases palpable nodes appeared following treatment.

Cancer of the lip is nearly always squamous-cell in type. The diagnosis is usually easy. Tuberculosis of the lip and chancre may resemble cancer but usually show less induration. In chancre there is usually bilateral enlargement of the lymph nodes, with a short history. Other rare conditions which may resemble cancer are hemangioma and aberrant salivary gland tumors.

Dental sepsis is first treated. It is often necessary to remove several teeth. Tumors thought to be too indurated or too large for x-ray therapy are treated with radium implantation, 7,000 r being given in about seven days. Of 16 patients thus treated, 6 were alive and well one year later.

Of the 46 patients receiving contact x-ray therapy, 14 had palpable nodes when first seen and in 5 these developed during treatment. Eight had Stage I tumors, 33 Stage II, and 5 Stage III. Thirty-seven were alive and well three years following treatment, but these are not classified according to stages. In one case a second epithelioma developed on the upper lip two years after treatment. The treatment factors were 60 kv., 4 ma., and focal skin distances of 3, 5 or 7 cm. A total surface dose of 8,000 r is given in 10 daily doses of 800 r each, treatment being omitted on Saturdays and Sundays. If the tumors are bulky, two opposing fields are used and, if large, two adjacent areas.

With small primary lesions and no palpable nodes in the neck, prophylactic surgery or irradiation to the neck is contraindicated. When small mobile nodes are present, a block dissection should be done as soon as possible. It is usually advisable to excise the primary lesion also. If the metastatic nodes are fixed, the choice of treatment lies between interstitial radium and high-voltage x-rays. With a single fixed node, implantation will usually be successful; otherwise high-voltage x-rays give better palliation. Eighteen of 34 patients showing adenopathy (53 per cent) were well and free from disease at the time of the report.

SYDNEY J. HAWLEY, M.D.

X-Ray Therapy of the Heart in a Patient with Leukemia, Heart Block, and Hypertension. Report of a Case. H. Blotner and M. C. Sosman. New England J. Med. **230:** 793–796, June 29, 1944.

A 64-year-old female with long-standing hypertension had a myelogenous leukemia that responded well to spray irradiation for two years. A 2:1 heart block then developed, believed to be due to leukemic infiltration of the bundle of His. Irradiation was applied directly to the cardiac region giving five times 200 r from Aug. 11 to 25, with 200 kv., 50 cm. distance, and 0.5 mm. copper filtration. The block was relieved. The treatment was repeated in November and December because of recurrence of the block. Later, spray radiation was given because of elevation of the blood count, but this had no definite effect on the heart block. The patient died the following May with a right hemiplegia. JOHN B. MCANENY, M.D.

Case of Acute Leukemia Complicating Pregnancy, with Necropsy Findings in the Fetus. H. S. Applebaum. Ohio State M. J. **40:** 536–537, June 1944.

A case of acute myeloid leukemia developing in the first half of pregnancy is reported, with postmortem findings in the fetus. The onset of the illness occurred during the third month of pregnancy, and the course was progressively downhill. A Cesarean section was performed at about eight and a half months in the hope of saving the child and perhaps rendering some relief to the mother. The fetus was found dead and the mother expired several hours later.

Autopsy on the fetus revealed atelectasis, along with aspiration of meconium and vernix caseosa in the lungs. There were parenchymatous and subserous hemorrhages in the viscera without regional cellular infiltrations, apparently due to intra-uterine asphyxia. There were no leukemic infiltrations of the lymph nodes, spleen, bone marrow of the ribs, or of any of the 23 sections taken from the various organs.

This case is of unusual interest because of the development of acute leukemia during pregnancy and as affording further evidence that a leukemic mother will not give birth to an infant with leukemia.

ELLWOOD W. GODFREY, M.D.

Treatment of an Unusual Hemangioma. I. I. Kaplan. Urol. & Cutan. Rev. **48:** 290–291, June 1944.

Hemangiomata are benign congenital lesions. They occur rarely in Negroes. The simple, small hemangiomata may be adequately treated by either surgery or irradiation. Large, bulky, or ulcerated lesions, however, do not lend themselves to surgery; irradiation is the only means of controlling them. Radium element is best utilized in large lesions. The number of radium elements, size, and dosage depend on the size of the tumor.

A case is reported of an unusual hemangioma of the upper lip in a 41-year-old West Indian Negro. The hemangioma had increased steadily in size for twenty-five years and had become so large that the patient found it difficult to talk or to swallow solid food. Interstitial radium therapy was carried out in two stages, the dosages being 2,000 and 1,354 mg. hours, respectively. The hemangioma slowly responded to treatment, and five months later the patient was able to eat, drink, and speak normally.

MAURICE D. SACHS, M.D.

NON-NEOPLASTIC DISEASE

Pelvic Actinomycosis Treated by Surgery and Roentgen Ray, with Recovery. Maurice Rashbaum and Harriet C. McIntosh. Am. J. Obst. & Gynec. **47:** 849–854, June 1944.

Actinomycotic infection of the internal genitalia of the female is uncommon, and recovery is rare. The authors report a case with apparent cure of this malignant disease. [As pointed out in the report, this case was previously recorded by Lisa and Levine (Arch. Path. **23:** 53, 1937), with special emphasis on the pathological findings.]

The patient was a 30-year-old woman with a mass in the lower abdomen and another in the cul-de-sac, associated with evidence of severe infection—septic temperature, rapid sedimentation rate, hyperleukocytosis, and secondary anemia. Following repeated pelvic drainage, which yielded thick greenish pus, but produced only temporary relief, laparotomy was performed, revealing a dense network of adhesions in the pelvis, with tubes, ovaries and uterus agglutinated to the cecum, sigmoid, rectum, and anterior abdominal wall. The tubes were dilated, thick-walled, and tortuous, containing thick pus. A bilateral salpingo-oöphorectomy and supracervical hysterectomy were done. The operative specimen included an adnexal mass and a separate tubo-ovarian tumor, which were found to consist of actinomycotic abscesses containing lobulated masses of mycelium in liquid pus.

The patient was given large doses of potassium iodide postoperatively, but this failed to prevent recurrence. A tender indurated mass, 7 × 8 cm., appeared in the left lower quadrant several weeks after discharge from the hospital, and three weeks later a second mass developed on the right side.

Roentgen therapy having been determined upon, the mass in the lower left quadrant was first attacked. It was treated daily, starting Feb. 25, 1935, through alternate anterior and posterior portals, at the rate of 300 r per day (200 kv.p., 30 ma., 70 cm. target-skin distance, 0.5 to 1.0 mm. Cu filtration), a total of 2,100 r being given to each portal, in a period of three weeks. The mass gradually diminished in size. A small residue was again treated in June 1935, 100 r being given daily to alternate anterior and posterior fields up to a total of 1,000 r each. In two months it had disappeared.

The right-sided mass, located at a higher level in the abdomen and firmly adherent to the abdominal wall, was more recalcitrant. Treatment was begun March 20, 1935, and continued at intervals until September. Several cycles were given in this period, totalling 5,700 r per field, a total of 11,400 r, which is among the highest doses reported in the cure of abdominal actinomycosis. Skin reactions were never excessive.

The patient was last seen in February 1944, with no evidence of disease. A gain of 76 pounds since her lowest weight, in 1934, was recorded.

The authors conclude that the method employed in this case, surgery followed by fractional roentgen therapy with high total dosage, is probably the most effective treatment for abdominal actinomycosis.

STEPHEN N. TAGER, M D.

Management of Acute Postoperative Parotitis. Hugh F. Hare. S. Clin. North America **24:** 603–606, June 1944.

Acute parotitis is a rare postoperative sequela which may develop at any time during the first week following surgery but usually occurs within forty-eight hours. Radiation therapy should be instituted immediately after the diagnosis is made, even though the condition may not be severe. In the author's experience only small doses of radiation are necessary to bring about improvement, and superficial therapy has been found as valuable as deep therapy. At the Lahey Clinic superficial therapy is usually employed: 125 kv.p., 3 mm. Al filtration, with a large enough portal to cover the entire parotid region including the accessory parotid gland (usually a 10 cm. square or round portal at a distance of 30 cm. is sufficient). The first treatment, as a rule, consists of 200 r, with a second application if the swelling does not materially decrease within twenty-four hours. Surgery should be deferred until radiation treatment has had an opportunity to bring about a successful result, *i.e.*, at least forty-eight hours, and is necessary only in the extreme case.

Radium may be employed in place of roentgen rays in the treatment of parotitis, but it is more difficult to use and more expensive for the patient. Since the applicators are heavy, the application of radium to the cheek on the affected side usually increases the discomfort of the patient and requires his co-operation. The shorter the period of application, the better; 400 mc. of radium are used, with 2 mm. brass filtration, at a distance of 1 cm. from the skin, for one hour. Treatment is repeated in twenty-four hours if necessary.

Sulfa drugs have not been employed at the Lahey Clinic in the treatment of parotitis without radiation treatment, and the author is therefore unable to judge whether the course of the disease is altered by their use.

Surgery, consisting in incision and drainage of the entire parotid region, undoubtedly will continue to have a place in the treatment of this condition when simpler methods fail.

DOSE MEASUREMENT

A New Integrating Dosemeter for X-Ray Therapy. F. T. Farmer. Brit. J. Radiol. **17:** 160–162, May 1944.

An integrating dosimeter is described which requires only the ionization chamber to be placed in the beam. The rest of the mechanism can be mounted elsewhere, making the instrument more flexible and the tube head assembly lighter. At a dose rate up to 40 r per minute the instrument is accurate within 1 per cent. At dosage rates higher than this, the error is appreciable. The wavelength characteristic is flat over a range of 1.4 mm. to 2.2 mm. copper half-value layer.

SYDNEY J. HAWLEY, M.D.

RADIATION EFFECTS

Foam Cell Plaques in the Intima of Irradiated Small Arteries (100 to 500 Microns in External Diameter). John F. Sheehan. Arch. Path. **37:** 297–308, May 1944.

"An uncommon, or at least a rarely described, lesion of small arteries (100 to 500 microns in external diameter) has been observed in several irradiated organs. The lesion consists of a plaque-like thickening of the intima due to a collection of foam cells alone or of foam cells mixed with various other cells, fluid, fibrin or hyaline material, between the endothelium and the internal elastic membrane. Pathologic changes may be found in the adjacent internal elastic membrane, media and adventitia, but these structures are often normal. The plaque may cause marked narrowing or even occlusion of the lumen of the vessel. Thrombosis, fibroblastic proliferation of the intima, or deposition of elastic tissue in the thickened intima seldom results.

"These foam cell plaques have been found in the arteries of organs subjected to roentgen therapy only, radium therapy only or to both combined.

"The plaques probably result from migration into the intima from the blood stream of lymphocytes and monocytes and subsequent transformation of these into foam cells by their ingestion of lipids which have been freed by the dissolution of red cells in the intima or which have accumulated in the intima after passage across portions of the endothelium rendered more permeable than normal by irradiation.

"The foam cell plaques in irradiated small arteries closely resemble the early lesion of atherosclerosis."

The preceding paragraphs are the author's summary of his observations of a radiation effect that has received little attention. The plaques which he describes were observed in 8 specimens excised at varying intervals of time after the completion of courses of radiation therapy. Among these specimens were included 1 adenocarcinomatous rectum treated by separate courses of roentgen and radium therapy; 4 uteri from which adenocarcinoma of the endometrium had been eradicated by combined roentgen and radium therapy; 1 uterus with adenocarcinoma of the endometrium in which the neoplasm had not been destroyed by combined roentgen and radium therapy; 1 uterus with adenocarcinoma of the endometrium treated by radium therapy only; and finally 1 uterus with adenocanthoma of the body which had been subjected to roentgen irradiation only.

The author could find no reference to this phenomenon in the literature beyond a single illustration in Wood's chapter on Radiobiology and Radiopathology in Pohle's Theoretical Principles of Radiology (Lea & Febiger, 1938), having the legend: "Radium effect on arteriole. Xanthomatous endothelial cells filling the lumen," without further explanation.

EXPERIMENTAL STUDIES

Transplantable Osteogenic Sarcomas Induced in Rats by Feeding Radium. Charles E. Dunlap, Joseph C. Aub, Robley D. Evans, and Robert S. Harris. Am. J. Path. **20:** 1–21, January 1944.

Thirteen male Wistar rats, five months old, were each fed a total of 100 μg. of radium chloride. The stock radium solution contained 1,500 μg. of radium taken up in 13 c.c. of glycerine and 26 c.c. of normal saline solution. Each rat was given three drops of this solution daily for twenty days. Within ten days after the final feeding, the animals had excreted 95 per cent of the radium; the average amount retained at the end of ten months was only 2 μg. None of the rats showed objective signs of disease during the first eight months of the experiment, but then, one by one, 9 of them exhibited paralyses of the hindquarters, while the others became progressively emaciated and cachectic. All surviving animals, together with 2 controls, were examined roentgenographically ten months after the radium feeding, and no significant changes in the skeletons were seen. Autopsy revealed osteogenic sarcoma in 9 of the 13 rats. The induction time, from the first radium feeding to the discovery of the tumors, was 253 to 426 days and averaged 365 days. The primary growths were in the vertebrae in 7 rats and in the pelvic bones in 2. All of the growths were so situated that they either had, or might have, exerted pressure on the spinal cord or major nerve roots, thus explaining the terminal paralyses that occurred in all but one of the tumor-bearing animals. Two of the primary tumors metastasized, one to the pelvic lymph nodes and one to the spleen. Three of the tumors were successfully transplanted to other rats. One has been maintained through seven serial generations. The high phosphatase level present in the original tumors has been maintained in subsequent transplants.

The bone marrow of all of the rats was hypoplastic and showed generalized immaturity and abnormal deposits of hemosiderin. Extensive hemosiderosis was present in the spleens, together with slight atrophy and extramedullary hematopoiesis. Widespread necrosis of bone was present in all of the rats and atypical new bone formation was found in all but one. Partially frustrated attempts at bone regeneration in regions of radium necrosis may be responsible for the ultimate appearance of osteogenic sarcomas.

The histologic changes observed in these 13 rats closely parallel the pathologic findings of radium poison-

ing seen in watch dial painters. The outstanding difference lies in the uniform finding of hypoplastic bone marrow in the rats, whereas many of the dial painters had a hyperplastic, regenerative marrow. This difference may be due to the fact that the amount of radium retained by the rats was much greater in proportion to body weight than in the dial painters.

A useful bibliography is appended.

Concentration of Red Blood Corpuscles Containing Labeled Phosphorus Compounds in the Arterial Blood after the Intravenous Injection. Preliminary Report. Gustav Nylin and Mignon Malm. Am. J. M. Sc. **207:** 743–749, June 1944.

A prolonged circulation time in heart disease means a slow circulation and is a criterion of decompensation. There are, however, many patients without signs of congestion or decompensation, with normal venous pressures, but with dilatation of the heart and a pathologically great heart volume in which the circulation time is markedly prolonged. Duration of the taste sensation of decholin is also prolonged in these cases.

In order to determine the role of the residual heart blood in prolonging the circulation time, the velocity of blood flow was studied by labeling the patient's blood with radioactive phosphorus. A small amount of the labeled blood was re-injected intravenously. At the same time, samples of arterial blood were taken at intervals of several seconds from the opposite arm. The amount of activity of the corpuscles of each sample was measured with a Geiger counter.

In a normal subject, the labeled corpuscles appeared in the arterial blood in about thirteen seconds, reaching a peak at nineteen seconds after injection, and falling rapidly to a minimum at thirty-three seconds. A new lower peak appeared at about thirty-five to forty-three seconds, probably as a result of recirculation. There was a strong correlation with the decholin taste test, which appeared at fifteen seconds and persisted to thirty-four seconds.

In a patient with severe cardiac dilatation due to mitral stenosis, the labeled corpuscles reached a peak at twenty-five seconds. During the period from thirty to sixty-five seconds there were small irregular peaks in the curve. The decholin taste test appeared at twenty seconds and persisted to ninety seconds.

In the normal there is a good correlation between the velocity of blood flow as determined with corpuscles labeled with radioactive phosphorus and as determined by the decholin taste test. In cardiac dilatation without congestion there is evidence to suggest that the residual blood in the heart plays a part in the prolongation of the circulation time.

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On the Maximal Energy Attainable in a Betatron (Letter to the Editor). D. Iwanenko and I. Pomeranchuk. Physical Rev. **65:** 343, June 1 and 15, 1944.

The authors writing from the Physical Institute of the Moscow State University, U.S.S.R., give calculations as to the maximal energy attainable in a betatron. They observe that the rotating electrons in the magnetic field must necessarily radiate energy. Therefore, they cannot be accelerated past the place where they are radiating energy as fast as the changing magnetic field is delivering energy to them. Taking the value for the magnetic field now in use, in present models of betatrons, they arrive at a limiting value of five hundred million electron volts, which is only five times as great as the energy which one expects to obtain from the betatron now under construction (at the University of Illinois). A higher value could be attained by reducing the magnetic field and increasing the frequency.

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